A Review on Railway Infrastructure and Wagon Health Monitoring and Traffic Controlling Using Wireless Sensor Network

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***ABSTRACT*— Wireless sensor network-based monitoring systems are now widely used for Railway traffic managing and monitoring for early anomaly detection that can cause huge losses for railway system now IoT based designs has paved a new way to build fast and more efficient condition railway infrastructure monitoring systems at remote locations in railway network segments are emerging. Also, the different methods to harvest energy requirements of wireless sensor network in off grid locations are upcoming feature of integrated systems. Recent developments in Smart Phone features and wide availability of GSM network have added extra dimensions to the have increased the speed of the response of detection of anomalies in condition railway monitoring and exchange of information to avert the accidents. This paper briefly surveys the different methodologies which can be integrated for more proficient and solid remote sensor network-based innovation for faster and safer railway operations.**

Keywords— WSN based monitoring, IoT, Off Grid Energy Harvesting, Smart Phone GSM based detection.

I. INTRODUCTION

Indian Railway is becoming increasingly smart and more and more user friendly now. It is becoming faster in operations and disseminating information to the passengers, railway staff and operations people thanks to Internet technology, smart phones and to widely spread GSM and wireless networks available today around every corner of our country. Since our country is highly populated and to reduce traffic and congestion which causes more and more pollution in cities by burning fossil fuels, the only Smart and sustainable rail transport mode is a rail road going to be only prominent solution. It's faster and more economical way of transportation. The recent economic growth is giving an opportunity to our rail network to cater the need of the densely populated our country as well as to need for security needs at the borders of the country has given a rise to build the railway network which was never anticipated ever before in India. This paper reviews all recent technologies going to impact the railway infrastructure monitoring traffic control and energy optimization areas. The quick detection and diagnosis of problems and hiccups in the railway infrastructure is crucial for a secure and reliable railway system. In order to reduce the likelihood of failure in the railway infrastructure, it is necessary to get, gather, and process complete data about the technical status of instruments as well as to enable life cycle and forecast for any damage to the electrical equipment. Passenger safety and railway infrastructure safety is the highest priority of the technology to be implemented. WSN based technology is now widely applied in Railway applications in India.

We found a work [17], Safety and railway accidents are important considerations for the global railway industry. Accidents are frequently caused by track failure. Before a train approaches a broken section of track and is involved in an accident, the break in the track must be detected in real time. For the sake of life security and efficient service management, railroads are facing a difficult and significant problem. In this study, a vibration sensor was employed to look for fractures and other obstructions in the railway tracks. With the aid of a load cell, switching circuitry, and an IR sensor, the tunnel light turns on and off as trains arrive and exit the tunnel, respectively, to reduce energy usage. Some other enhanced method defines [18], In this sensor, sudden accidents are avoided by using ultrasonic technology. Using ultrasonic sensors, this technology hook hurdle inside the tracks and prompt us with alarms. Using this mechanism, ships can also be automatically stops when there is a hurdle in the way for a long time after the alarm is bring about. Air brakes can be used to train stop. Improper monitoring or detection of people, animals or other vehicles inside a railway line leads to an increase needs for inspection and maintenance of railway assets. Energy is used in the boogie when the train enters and exits the tunnel,

respectively, using the load cell and switching circuitry for the energy consumption in the tunnel. The European Railway Traffic Management System (ERTMS) [19] Level 3 mandates that all trains continuously and reliably self-monitor and report their integrity and track location without infrastructure support in order to maximize railway use efficiency. It can be difficult to identify train separations in time, particularly for long goods trains without electrical power on the cars. Data fusion of various monitoring methods, such as distributed integrity sensing of all train couplings, is currently being researched. A new method found [36], to track the behavior of structures during forced vibration testing or natural excitation (such as earthquakes, winds, and live loading), structural health monitoring devices are frequently used. They are used in applications for vehicle health monitoring as well as in a variety of civil constructions, such as viaducts and bridges. Additionally, because threats that originate from people might harm infrastructure, implementing security measures is also crucial. This study makes a suggestion for a railway infrastructure monitoring early warning system based on wireless sensor networks (WSN). It makes use of research findings and tools that are already available for WSN management, integration, and data fusing. The goal is to provide a comprehensive framework for hedging detection capabilities against both structural failures and security risks, such as both natural disasters and deliberate attacks. This paper is structured as the section II defines the domains of WSN where sensers uses, section III explains the role of energy harvesting using WSN, section IV describes the traffic monitoring with WSN, and finally section V concludes this paper.

II. WSN BASED SENSING AREAS

*A. **Railway Track monitoring Systems***

Railway is most economical faster and reliable mode of passenger and freight transportation modes. It has large infrastructures, some of the structures are as old as 155 years especially bridges, Tunnels, Railway stations etc. the system includes a network of sensors that are spread along the track and are used to detect potential problems. The sensor measures various parameters such as temperature, vibration, and other physical properties of the track. The data collected by the sensors afterwards sent to a central monitoring station, where is where analysis is done and identify potential problems. The system can also be used to detect potential accidents and alert the appropriate personnel. The system can also be used to optimize maintenance schedules and ensure the safe operations of the railway. A new approach [29], Fuzzy Track Monitoring System (FTMS) is used to gauge the degree of irregularities on the railway track at any given moment. For detecting acceleration in the lateral and vertical directions, the vibration sensor is positioned on the train's axel box and bogie. The technology automatically sends the vibration's position and its source to the main office. The number of trains and their speed are growing every year even if there is the same amount of current rail tracks accessible. Indian Railways are lacking in monitoring such a huge infrastructure [1] with state-of-the-art modern methods. Rail Track monitoring plays the most vital role in safety of the Passengers as well as smooth traffic control. A new and enhanced method [2] Computer Vision based crack detection system provides accurate result than manual inspection of railway tracks. This technique is faster than the manual track inspection which is time consuming and expensive than computer vision-based detection. One of the essential components of a contemporary railway signaling system that is less expensive, safer, and more dependable is train integrity monitoring. The proposed train integrity monitoring system [20] is based on a WSN consisting of the coordinator and serial gateway (both deployed on a locomotive), the WSN nodes (deployed on each wagon) and the WSN coordinator. Each WSN node collects accelerometer and GPS data, which is then transmitted to the coordinator, who has the accelerometer and GPS reference readings, which are used to compare each node's measurements to determine the integrity of the train. In addition, the coordinator calculates the RSSI value of each node, so three measurements are used to determine whether the train is complete or not. When the train integrity is compromised, the coordinator sends an alert message to the Serial Gateway node, which is connected to the PC via a special GUI. Now a day's smart phone technology can easily measure the speed of the vehicle in which you are travelling. Internet based applications like Google maps and GPS systems in a smart phone can identify your current location. The major benefit of the systems is that very accurate picture of each train locations can be presented to a Train dispatcher in a centralized train traffic control room on real time basis. The optimization algorithms can be implemented based on these data and rescheduling of the traffic or train plat forming decisions can be optimized [3]. In order to create a workable solution that can be implemented on this scale, fresh ways must be researched due to the volume of assets that need to be supervised. The goal of continuous surveillance is then desirable since it is strongly related to big-data analytics, which enables problem prediction and response to unanticipated events. Infrastructure managers will benefit from having supported algorithms that make decisions easier as well as from having access to a huge volume of highly representative data collected in context. This article details the safety-related actions taken on one such system, which are eventually expected to take the place of the current level crossing and railway point routine inspections [14].

We found a work [30], in which we proposed the first of its type, to collectively address elephant conservation by avoiding their being run over by trains and keeping track on the integrity of the rail track. Infrasonic sound is used in a novel way to prevent elephants from crossing the rail track. Using a cutting-edge passive node mobility mechanism, the sensing devices are positioned close to the train track to collect this output. These gadgets serve as an input for the sensor nodes that would really produce the infrasonic sound. The integrity of the rail track is assessed using a revolutionary two-cycle communication and sensing check, and the outcome is communicated to the regional base station (RBS). The suggested strategy provides a potential resolution to the two problems, pending validation and field testing. We discovered a publication [37] that describes how structural health monitoring (SHM) applies an approach for characterizing degradation and detecting it in engineering structures. The main SHM issues for railway tracks are track alignment, crack formation, material corrosion, track deformation, and missing tracks. Currently, wired sensor networks installed across railway tracks, GPS communication technologies, and oral

telephone communication are all used to monitor the structural condition of railway tracks, but these approaches have long reaction times. This method's objective is to use a Wireless Sensor Network (WSN) to monitor the structural health of railway rails. The response time will be faster with this prototype than with the current system, and the cost will be lower.

B. Railway Train condition monitoring systems

Most individuals choose to travel larger distances by rail since it is less expensive. The Indian Railways has not taken fire accidents seriously since the introduction of trains for use as passenger transportation. Railway Passengers often carry inflammable materials and smoke even it is prohibited while travelling in a train. Due to highest volume of passengers the security and monitoring systems are meager to cater the scrutiny of the luggage and monitoring behavior of the passengers for possible fire threat. This research has studied the variety of WSNs used in the railway industry for condition monitoring. The focus is on realistic technical solutions, particularly on the types of sensors utilized and their intended applications, as well as on the layouts of the sensor nodes and network topologies. The study splits railway condition monitoring [16] into movable monitoring for vehicles and their mechanics and permanent monitoring for immovable infrastructures such bridges, tunnels, tracks, and associated equipment. Fixed monitoring employs sensors to track changes in stresses, pressures, and sound waves that travel through buildings over time as well as vibrations, strains, and sound waves that are created by passing trains (short-term monitoring). Over the past twenty years, there has been a widespread utilization of advanced sensing technologies based on fiber optic sensors for structural health monitoring (SHM). These sensors offer unique advantages such as compact size, lightweight, resistance to electromagnetic interference (EMI), corrosion, and the ability to be embedded within structures. Monitoring systems based on fiber optics enable real-time measurement of structural parameters and their continuous evaluation over time using both quasi-distributed and continuously distributed sensing methods. The most recent developments in fiber optic sensing and monitoring technologies are examined in this article [21], which covers the principles of various optical fiber sensors, state-of-the-art sensing and computational methods, and practical applications for monitoring railway infrastructure. The application of these technologies to monitor temperature, stresses, displacements, and strain measurements as well as train speed, mass, and location will also be thoroughly covered. Additionally discussed will be axle numbering, wheel faults, rail settlements, wear and tear, and the state of railway bridges and tunnels. The most recent developments in fiber optic sensing and monitoring technologies are examined in this article [21], which also discusses practical applications for monitoring railway infrastructure. It covers the fundamentals of numerous optical fiber sensors as well as cutting-edge sensing and computational approaches. A thorough explanation of how these technologies can be used to track temperature, stresses, displacements, and strain data as well as train speed, mass, and location will also be provided. The state of railway bridges and tunnels will also be discussed, along with axle counting, wheel faults, rail settlements, wear and tear, and problems in the rails. Hence WSN based train assets condition monitoring the onboard fault detection systems appears as a good approach for energy optimization as well as the fire safety. The zigbee wireless sensor network technology is the foundation for autonomous sensor monitoring, fire alarm warning, and fire extinguishing. It is inexpensive and uses little power and has a transmission range limitation and the data speed limitations. Besides this, it is providing a standardized platform but having much potential since it is more reliable and secure. They are designed to be robust and secure against external interference. Zigbee networks are easily scalable, allowing you to add or remove nodes as needed. This makes them ideal for applications that require different levels of coverage or capacity. Finally, WSNs also allow for the implementation of predictive maintenance systems which can anticipate potential fault or damage to trains before they occur. WSNs are relatively simple to deploy and manage, making them a cost-effective solution for railway train condition monitoring. According to a recent study [35], condition monitoring has several uses in the railway sector, and different monitoring strategies have been suggested for the examination of wheel and rail conditions. The real-time data needed for maintenance planning is provided by the in-service condition monitoring of wheels, whilst in-workshop inspection is often performed on a regular basis at predetermined intervals. On-board and wayside measurements are two categories of in-service data collection. Based on these categories, the state-of-the-art approaches and necessary research are described, and the current data gathering strategies for the monitoring of railway wheel condition are evaluated in this work. The design of power requirements needs to be optimized for a long-lasting operation.

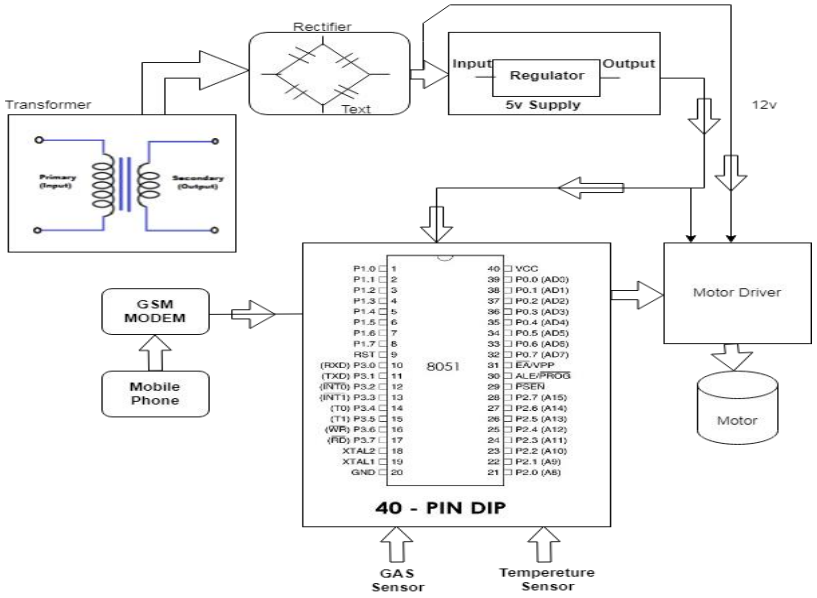

Figure. 1. Interfacing Diagram for monitoring and regulating temperature and humidity in a coach.

This proposed system is capable of monitoring real-time parameters viz temperature and humidity in each coach. The innovative architecture of the link between DC Drives and the DC motors that power the locomotives allows the system or engine driver to make decisions on firefighting, alarming, and automatic functioning of the train brake system more quickly. The new interface will immediately halt the train and the engine driver will receive a warning light. Further the loco pilot can inform to the immediate concern authority for help [3].

C. Railway station monitoring systems.

Now a day's railway infrastructure has expanded very fast to monitor and control traffic its uses of wireless as well as wired communication systems. Ensuring the safety and dependability of a railway station, encompassing its physical equipment and assets (both mobile and stationary), individuals (such as passengers, employees, and the general public), as well as the monitoring and facilitation devices (e.g., closed-circuit television, HVAC systems, fire systems, screening systems, etc.), poses a significant challenge in terms of maintenance and upgrades. If in any case these environments are exposed to any kind of threats and these are distributed systems with different type of sensors and wireless protocols. In addition, the threat of terrorism now becomes a major challenge, especially at public transport hubs. Thus, a quick response is anticipated from WSN based Station Monitoring systems and all kind of security are required for transportation systems. A new method [22], proposed an early warning system based on Wireless Sensor Networks (WSN) for railway infrastructure monitoring. The goal is to utilize existing research findings and tools related to WSN (Wireless Sensor Network) management, integration, and data fusion. The objective is to enhance detection capabilities within a comprehensive system that addresses structural failures and security risks, encompassing both natural disasters and deliberate assaults.

A vision-based monitoring system [27] for passenger safety on platforms. The suggested system employs a stereo vision algorithm for its detection process, aiming to enhance the system's performance in detecting incidents. This is particularly important as the lighting conditions in the scene vary due to the arrival and departure of trains. By relying on vision-based monitoring, the system can identify potential accidents like passengers falling on the tracks or getting trapped between train doors. In such cases, the system promptly alerts operators with an alarm, enabling them to respond to emergencies promptly. Train stations with sensors and devices installed in sensitive areas should play a crucial role in controlling pedestrian congestion or in the event of an emergency. A platform surveillance system [24] using image processing technology for passenger safety in train stations. The proposed system uses multiple cameras to monitor almost the entire length of the track line in the platform and, using image processing technology, determines in real time whether there is a person or a dangerous obstacle in the preset surveillance area. According to the experimental results, we verified the system performance in real state. The train state and object detection are performed robustly using the proposed image processing algorithm. In addition, the system provides the local station, the central control room and the train with video information and alarm messages for immediate treatment of the accident. A new overall system consists [25] of a solar power module, a cloud server and an IoT sensor. Compared to traditional train condition detection systems (i.e., computer vision or IR detectors), this system has the advantages of low cost, self-sufficiency, and no line occupation. We have shown that with this system, 24-hour real-time radio monitoring is possible without occupying track resources, which significantly improves the efficiency and quality of railway track detection. It can be used to track the movement of trains, detect anomalies in the railway system, monitor the environment of the station, and monitor the safety of the passengers. The system can also be used to detect any potential threats to the station such as fire, smoke, or other hazardous materials. The system can be used to alert the authorities in case of any emergency. The system can also be used to monitor the efficiency of the railway system and provide real-time data on the system's performance. This technology shows the severity determined by the controllers and can monitor and react.

Density, flow rates, and passenger demand and arrival are necessary data for the monitoring system. Manual density counting, either on the ground or via video images, has been shown to be prone to human error, which is one of the major limitations at present. In emergency situations like terrorist attacks, earthquakes or unexpected chaotic it creates a panic very quickly and disturbs the smooth functioning of the traffic activities it is mostly managed by a secured fully automatic system. The density or flow must be calculated by various methods like cameras, infrared or tracking sensors, Wi-Fi/Bluetooth, or a combination of these which has been suggested for future smart stations. In addition, CCTV can be used if it can be programmed with appropriate algorithms [4]. This research paper offers a comprehensive examination of wireless sensor networks (WSNs) designed for the purpose of monitoring and enhancing the security of railway stations. The article begins by providing a concise overview of the diverse range of WSN applications employed in various contexts. Furthermore, it emphasizes the significance of utilizing advanced tools and techniques, like WSNs, to gather a substantial volume of data from train stations, which represents a pioneering and innovative concept necessitating the development of artificial intelligence methods. The integration of machine learning into the railway industry is deemed crucial for its future advancement. A recent work found [31], Structural health monitoring systems are widely used to monitor the behavior of structures during forced vibration testing or natural excitation (e.g., earthquake, wind, live loading). These devices are present in various structures such as bridges, viaducts, and vehicle health monitoring applications. Additionally, since man-made threats can cause damage to infrastructures, it is crucial to implement security measures. This research paper proposes a railway infrastructure monitoring system that employs wireless sensor networks (WSN) as an early warning system. The system leverages existing research and tools for the management, integration, and fusion of data within WSN. The objective is to enhance the security of detection capabilities within a comprehensive framework, safeguarding against structural failures and security threats such as natural disasters and intentional attacks. This article [33] examines the use of drones on railways for early warning, situation assessment and decision support applications. It uses already available technological and research successes for drone-based surveillance. The aim of the study is to provide a preliminary assessment of drone capabilities in a railway surveillance framework, including structural deficiencies and the detection of safety threats, as well as investigating the consequences of natural hazards and premeditated attacks.

D. Railway Bridges and Tunnel condition monitoring systems.

Safety is of the utmost importance to the railway sector, as railway bridges and tunnels are vitally significant infrastructures that directly affect rail transportation. Many Railway bridges are over 150 years old now and are still used in traffic situations. Increased railway passengers have added load on such age-old bridges. The major limitation of systems discussed are they operate on ARM Processors based ZigBee technologies based on GPRS systems and but it only informs the Central Monitoring Systems, whereas on the field the Train Drivers receives information either very late or does not receive at all about degradation of Rail Bridge or the Tunnel and it is not designed to handle high data rates. Additionally, it has limited range and is not capable of supporting multiple nodes, making it a poor choice for application requiring a large amount of data or extended range. Additionally, the latency associated with GPRS can lead to delays in message delivery.

A system based on wireless sensor networks [23] can be used to monitor the condition of vehicles like wagons, bogies, and wheels as well as railway infrastructure including bridges, rail tracks, and track beds. Systems, structures, vehicles, and equipment are all studied using the wireless sensor network technology for monitoring in the railway business. The identification of sensor setups and network topologies, as well as practical engineering solutions, is the main points. There were many incidences in Mumbai Railway region where Railway traffic was disrupted by hours due to collapse of Railway bridge and many lives were lost therefore continuous monitoring of the infrastructure with early warning systems and immediate indication of a local indication of the status of the Rail Bridges as well as Tunnels shall ensure the safety of railways infrastructures using more MEMS based WSN network is important area is a imperative for prevention of the accidents and to save the infrastructure for smooth functioning of the railway operations [5]. Wireless sensors networks have become a key technology for monitoring and controlling railway bridges and tunnels. WSNs can be used to collect data on the structural health of the bridge or tunnel such as strain, temperature, and vibration levels, which can be used to detect potential flaws or damage before they cause serious problems. WSNs can also be used to monitor environmental conditions such as the presence of dangerous gases, and to communicate with other control systems to ensure the safety of trains, passengers and staff. In this study [32], the transfer speed, schedule, axle load, and train length of the railroads are all pushed to their physical limits in order to produce a high load. Monitoring these strategic structures is therefore becoming increasingly crucial. The installation of traditional sensors is costly and time-consuming.

Together with new or improved monitoring techniques, new wireless sensor systems and distributed processing algorithms promise early damage detection and damage quantification. In order to measure and extract bridge vibration characteristics, this research constructs a wireless sensor network for structural health monitoring utilizing commercially available wireless sensors. In a lab experiment, the network's functionality is confirmed.

III. ENERGY HARVESTING FOR WSNs

Wireless sensor network is managed throughout and automated by different kind of sensors to support display infrastructure, Physical structures, man and machines, and soft tracking targets. This system will monitor data from all sensors in the railway industry in real-time, turning data into reports that aid in issue detection and operating assistance. Due to power restrictions, specialized sensors are placed very close to the tracks to monitor the condition of the railway infrastructure, and they use communication nodes to send the information they collect to the base station. The overall monitoring region is split up into a number of smaller sub-monitoring zones using the double-layered approach. The data from all of the smaller sub

monitoring areas is then transferred from the sink node to the base station. A sink node is then installed at the edge of each of these sub-monitoring areas to receive the monitoring data from that region. The method can guarantee that the data learned from each sensor node can be transmitted to the base station without interruption, in addition to significantly reducing the power consumption of sensor nodes and extending the lifespan of specialized wireless sensor networks. The creation of a two-layer wireless sensor network for use in a railway condition tracking system [6]. Major portion of the railway track is at very remote areas where wireless GSM network as well as Satellite based network is easily available, however the electrical grid power is not available for powering up the WSN based systems. India is a very huge country and weather conditions are very extreme. Hence solar power-based energy harvesting is not guaranteed solution many times. Besides in many parts of our country the monsoon is for more than 90 days, snowfalls in winter also affects the energy harvesting for off grid locations at railway applications. Wireless sensor node has low energy storage capacity. Very often these batteries are not accessible easily and cannot be replacing due to its remote locations. The life cycle of WSN nodes, and occasionally the entire wireless network, is determined by energy efficiency, which may reduce the effectiveness of the condition monitoring of the rail infrastructure. Additionally, due to the high data volume and frequency of transmission, the WSN nodes' energy efficiency may have an impact on the accuracy of the data monitoring. Energy is lost in mechanical systems in transmission of power as well as power transformation in the form of heat, vibrations, deformation etc. by harvesting such available resource the WSN nodes can be powered up and it will save the replacement of batteries as well as it will be totally maintenance free highly efficient monitoring systems. Mechanical systems experience energy losses in the form of friction, heat, deformation, and vibration during power conversion and gearbox while the system is in use.

As a result, it is acknowledged that mechanical efficiency is never 100% [7]. Developments in advanced materials nanotechnologies are successfully deployed in various portable electronic devices such as wearable devices, Human Heath monitoring systems etc that are more efficient WSN construction-based topologies but not applied to Railway Condition Monitoring systems. Additionally, the environment for monitoring railway infrastructure is anticipated to contain increasingly effective, renewable, and typically renewable energy sources in the near future. According to a recent study, wireless sensor networks with intelligent processing capabilities are becoming more and more important for online machine condition monitoring [34]. WSNs are economical networking systems for keeping track of machine health. It saves a lot of money by avoiding cable usage and simplifying system implementation in the industrial setting. A genuine WSN system has many difficulties, including powering the nodes, especially when they are placed in hazardous or difficult-to-reach areas and in harsh conditions. Engineers have become interested in promising energy harvesting technologies because they use WSNs to construct maintenance-free machine status monitoring systems by converting microwatt or milliwatt level power from the environment. This review's goals are to look into energy sources, promote the use of WSNs that are energy harvesting based, and assess how well energy harvesting systems are progressing for monitoring mechanical condition. By examining the power consumption of WSNs and the potential energy sources in mechanical systems, this paper provides an overview of the fundamentals of many energy harvesting methods that are suitable to industrial machinery. Particularly in the mechanical industry, numerous models or prototypes with various aspects are examined. A comparison of the benefits and drawbacks of energy harvesting devices is used to determine if they should be developed further. The difficulties and potential directions for future research in energy harvesting systems for WSNs used for machine condition monitoring are then discussed.

IV. RAILWAY TRAFFIC MODELS

The real-time rail traffic control (RTC) problem also involves figuring out a lowest-cost real-time plan that represents an appropriate route for each train, as well as the specific time that the train enters each segment of its route [8]. Punctuality and Regularity are the main performing index parameters to develop the traffic control algorithms. However, the human operator response is unpredictable to a system response and is observed that out of the real time railway traffic control loop. Since the trains travel very long distances and exposed to harsh environmental changes, mechanical failure of equipment, man-made accidents and many factors which are out of rail traffic monitoring systems can affect the train arrival punctuality as well as departure time at a particular location. Hence real time traffic management and control is becoming a difficult task due to demands of new trains and heavy freight and passenger traffic. At the same time new bottle necks are observed such as clearing the railway platform for passengers of the next train scheduled otherwise it may cause heavy congestion on a platform and can be catastrophic and the passengers' safety will be in danger are also to be included in newly designed algorithms. Based on the priorities of each train, Official time table violation must be minimum while optimizing the real time traffic control. The balance must be made between the volumes of the passengers who are travelling in a particular train; priority of the train and many other factors affects the decision of traffic control. [9] Many mathematical models-based algorithms are developed to optimize the rescheduling rail traffic management problems. Optimized solution mainly depends on the speed limitations, passengers' comfort as well as the safety requirement of a single train. In case of emergencies the rescheduling of trains should be quick efficient and should be cost effective. First, the event must be correctly identified, which is essential in an emergency. Then the corrective measures are to be taken based on the WSN network and last should be conveyed to the operation staff as well as to the passengers. IoT-based smartphone technologies play a key role in disseminating information in emergency situations like this [10] the human factor plays an important role in railway traffic control and monitoring and is a highly dynamic field. Train controllers manually monitor and execute activities that control train tracks, points, and signals. They are also referred to as signalers, traffic controllers or traffic planners, in order to take the

traffic flow into account, the traffic controller changes the traffic plan if necessary [11].

V. CONCLUSION

WSN based rail traffic condition monitoring system is an eye of the rail traffic control system. It has a power to predict the event which can disrupt the traffic or may cause an accident. Hence loss of lives as well as infrastructure can be saved. At the same time the rail network is expanding to cater the exponential growth of passengers as well as freight. Various wireless technologies such as Bluetooth, Wi-Fi, GSM, and microwave technologies have a significant impact on WSN based rail monitoring technology. Since WSN nodes requires very less power on board several such nodes can be placed at optimized distance due to the availability of the power. For off grid locations many techniques have been explored and implemented successfully which are having a very low replacement of WSN node power supply batteries and they are almost maintenance free. At the same time WSN based systems have significant impact on train traffic rescheduling process as the information quickly passes to the train traffic controllers in real time basis. IoT based technologies speeds up the decision-making process thus results in energy optimization. Implementations of rescheduling decisions are now faster than before resulting a smooth optimized rail traffic management. Many mathematical modeling-based approaches has developed algorithm based automated systems to control a real time rail traffic can handle unexpected situations efficiently. the major benefits of WSN-based rail traffic monitoring systems include reduced equipment costs, improved safety, reduced maintenance costs, improved reliability, improved traffic control and improved energy efficiency. Hence WSN based monitoring systems will be now an imperative integral part of each segment in Rail infrastructure monitoring and control towards safer, energy efficient and faster transportation of goods as well as passengers.

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