Journal of Mines, Metals and Fuels, *73(7): 2233-2240; 2025. DOI: 10.18311/jmmf/2025/49174*

Print ISSN : 0022-2755

Journal of Mines, Metals and Fuels

Contents available at: *www.informaticsjournals.co.in/index.php/jmmf*

The Role of Radio Frequency Identification (RFID) Technology in Mining Industries and Other Fields

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Abstract

A recent economic boom in the mining sector is contributing to social development and economic recovery in a number of nations. The timing of RFID technology's emergence as the next mining industry revolution is ideal. Indeed, it is anticipated that RFID technology will change a number of mining operations, such as the gathering and sharing of real-time data among mining investors, the development of novel business models, and the application of techniques like build-to-order supply chain management, reverse logistics, total inventory management, and product anti-fabricating strategies. Radio-Frequency Identification (RFID) is used in the mining industry for a number of purposes, such as tracking explosives, controlling personnel access to mining sites, and managing Personal Protective Equipment (PPE). RFID technology's strategic potential to revolutionize mining operations has made it a recent dream for many businesses and organizations. The timing couldn't be better as RFID technology emerges as the next big thing in the mining sector. This research will examine how RFID is used in the mining sector, gather information about RFID technology, and examine the potential for this technology to play a significant role in the mining sector.

***Major Findings:** In the mining industry, Radio-Frequency Identification (RFID) is used to track explosives, regulate staff access to mining locations, and regulate Personal Protective Equipment (PPE). This technology has the potential to add economic value to several sectors and will bring about new developments in commodities mining.*

Keywords: *Application, Arduino, Industries, Mining, RFID*

1.0 Introduction

A major contributor to the economies of many nations globally, the mining sector is one of the oldest in the world. A current economic boom in the mining sector is contributing to social development and economic recovery in a number of nations[1,2]. It must overcome many obstacles pertaining to the new development of the projects in order to survive. Practically speaking, crucial choices are made throughout the mining industry's life cycle, from discovery to exploration to mine operations to rehabilitation[3,4]. Therefore, risk control is the most important factor. As a result, the possibility of conflicting significance cannot be eliminated entirely without making mining operations technically or economically unviable[5,6]. Mining is classified as a high-risk occupation, which will affect worker safety and health. Anytime now, the unpredictable thing could occur. It is now essential to

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take proactive measures to mitigate the hazards related to occupational safety and health[7,8]. This essay will examine how RFID is used in the mining sector, gather information about the technology, and examine its potential to play a significant role in the mining industry[9,10]. Decisions about the adoption of new technologies, such as RFID, require significant financial outlays and may have a strategic effect on the company[11,12]. The application of this technology from a management standpoint will be covered, along with various theoretical frameworks that can help organizations adopt RFID technology in the mining sector[13,14]. Due to its strategic potential and great operational efficiency in revolutionizing mining operations, RFID technology has recently captured the imagination of numerous companies and organization[15,16]. The timing of RFID technology's emergence as the next mining industry revolution is ideal[17,18]. Real-time data collection and sharing among mining investors, as well as the development of novel business models and practices like total inventory management, product anti-fabricating strategies, build-to-order supply chain management, and reverse logistics, are just a few of the mining operations that RFID technology is expected to change[19,20]. Furthermore, RFID technology allows for the reshaping of intra- and inter-organizational business activities, which may result in the emergence of smart processes. It is a procedure that minimizes the integration of intra- and inter-organizational information systems and can start commercial transactions without human intervention[21,22].

2.0 Literature Summary

Based on RFID technology's mobility, the tagged entity should primarily be able to become a mobile device that can intelligently communicate as part of the organization's entire internal information frame. The main goal of RFID technology is to enable the tagged entity to become a mobile device that can communicate intelligently and become a part of the organization's entire internal information frame[23,24].

3.0 Role of RFID in Other Area

For emergency vehicles, notably ambulances, that must have quick and undisturbed access to patients in life-threatening circumstances, increasing congestion in towns creates serious challenges[25,26]. The versatility and reaction required for satisfying the immediate needs of emergency services are occasionally absent from traditional traffic management systems. Although delays may result in serious repercussions, such as higher rates of morbidity and mortality, prompt medical action is essential for improving patient outcomes in crises. Research indicates that cutting down on travel time by even a few minutes might have a big influence on survival chances in life-threatening circumstances. However, heavy traffic in cities, especially during rush hours, can make it difficult for emergency vehicles to get through[27,28]. Ambulances are frequently not taken into consideration by fixed traffic signal timings, triggering delays at intersections. Furthermore, rapid travel is made more challenging by the possibility potential automobiles won't always yield the right of way. In addition, current systems fail to incorporate emergency response and traffic management, which leads to ineffective routing. Real-time traffic flow management is enhanced by Intelligent Traffic Control Systems (ITCS), which use technology[29,30]. These systems are able to react to changing environments by utilizing sensors, cameras, and advanced algorithms. The application of Radio Frequency Identification (RFID) technology, which may be used to track and rank emergency vehicles, is an important advancement in this field[31,32]. Ambulances equipped with RFID tags can link with roadside readers to notify traffic management systems that they approach. This enables the creation of clear routes and dynamic adjustments to traffic the light timings. Priority routing, which employs GPS and traffic data to determine the fastest routes, communication systems which enable real-time transfers between ambulances and traffic management centers, dynamic traffic signal control that changes signals for ambulances, and alerts to the public to urge motor vehicles to yield when emergency vehicles are approaching[33,34]. Reduced response times, improved safety by lowering the possibility of crashes including emergency vehicles, and data-driven insights that offer useful information for future traffic management and urban planning are all possible outcomes of the deployment of ITCS, particularly once RFID integration is included[35,36]. With everything considered, incorporating intelligent traffic controllers made for ambulances offers a great chance to speed up

emergency response times, improve patient outcomes, and make cities safer-all of which are essential as cities keep on growing[37,38]. An automated traffic controller is necessary for ambulances, especially in today's congested urban areas where traffic congestion is a persistent problem. Heavy traffic delays can have disastrous effects during medical situations, where prompt reaction times are essential[39,40]. Studies indicate that cut down on the time it takes an ambulance to land at its location greatly increases the likelihood that a patient will survive, particularly in circumstances involving trauma, severe injuries, or cardiac arrests[41,42]. The issue can be solved effectively by an intelligent traffic management system made especially to give ambulances priority, which will give them an immediate and straight forward path across even the busiest regions[43,44]. Such high-stakes, time-sensitive scenarios are just too demanding for traditional traffic systems, with their set signal gene sequences. The incorporation of cutting-edge technologies such as RFID (Radio Frequency Identification) becomes vital at this point. The technology can quickly identify an incoming emergency vehicle and change the traffic lights to give it precedence by equipping ambulances with RFID tags and installing RFID readers at traffic signals[45,46]. The clever system overrides the normal traffic patterns as soon has the ambulance is within range, turning signals green in its favour and halting traffic in other directions. Ambulances may go through congested streets without needless delays due to this immediate automated response, which likewise removes the need for human interaction[47,48]. This system is of greater significance than just making ambulances faster. It solves a significant safety issue while also speeding up reaction times[49,50]. In an attempt to get to hospitals as soon as possible, ambulances frequently have to make risky decisions like driving in the wrong lane, swerving through traffic, or running red lights. These behaviors raise the possibility of collisions, endangering not just the patients and ambulance staff but also other drivers. By giving the ambulance, a clear and secure path, an intelligent traffic management system-especially one that is RFID-powered- reduces need for such dangerous activity. By lowering the likelihood of crashes and accidents during emergency responses, this helps to make roadways safer[51,52]. A converter plays a crucial role in ensuring smooth integration and operation of various electronic components in the RFID-based traffic management system. In this system, different devices such as RFID readers, traffic signal controllers, and communication modules may operate at different voltage levels and signal types[53,54]. Furthermore, because of our current fast urbanization, there are more cars on the road and congestion caused by cars gets more common, particularly during rush hours. Ambulances encounter the same difficulties as other vehicles in the absence of a smart system, becoming stuck in traffic jams that can waste valuable time. Even in the most crowded situations, ambulances may successfully clear their path by using RFID technology to communicate with traffic signals in real-time[55,56]. This guarantees that ambulances can flow through traffic without any problems, irrespective of the time of day or the state of the roads[57,58]. The RFID-based Intelligent Traffic Management System reduces fuel consumption by minimizing vehicle idling, optimizing traffic flow, and reducing unnecessary stops at signals[59,60]. By giving priority clearance to emergency vehicles, traffic jams are avoided and all vehicles can travel faster, which reduces fuel waste from repeated halting and speeding up. Shorter travel times, increased fuel economy, and a significant reduction in carbon emissions result from this. Cities may improve road efficiency and support environmental sustainability by using such smart traffic structures[61,62]. Since it minimizes needless stops at crossings, optimizes vehicle movement, and reduces idle time, the RFID-based Intelligent Traffic Control System is essential for fuel conservation[63,64]. Traditional traffic signals frequently result in congestion, requiring cars to constantly brake, idle, and accelerate, which dramatically raises fuel usage. Emergency vehicles are given real-time priority clearance through the use of RFID technology, which ensures that they can get through crossings without any delays. This not only cuts up reaction times in emergency circumstances but also stops traffic jams from spreading to other drivers. Vehicles may keep a constant speed when traffic flow is smoother, which minimizes fuel waste from frequent braking and accelerating. Furthermore, less traffic means fewer emissions, which improves air quality and the sustainability of the ecosystem as an entire system[65,66]. Additionally, as the world grows more interconnected technologically, it is not only possible but also essential to use tools like RFID and the Internet of Things (IoT) in traffic control. Over time, these systems will become more intelligent and efficient

due to their ability to continuously learn and adapt. Intelligent traffic control systems that make use of technology like RFID will be crucial in guaranteeing that emergency services can function without interference as cities grow and traffic grows more complicated. The advantages of these systems go beyond traffic control; they are essential for enhancing public health outcomes by guaranteeing prompt medical attention and fostering safer driving circumstances for everybody. In urban areas, conventional traffic signals fail to prioritize ambulances, causing delays that risk patient lives. Dependence on human intervention to clear traffic is often inefficient and prone to error, especially in heavy congestion. Without automatic priority for emergency vehicles, intersections remain blocked; further hindering ambulance movement and delaying critical care. A real-time, dynamic traffic signal solution is needed to address this issue by granting ambulances a clear, priority path. Such a system would reduce congestion, improve response times, and ensure a safer, quicker route for emergency services, benefiting both public safety and overall road efficiency. In modern metropolises, traffic congestion results in major delays for rescue vehicles, especially ambulances, which can be vital in situations where life is at stake. An intelligent traffic management system that uses RFID technology offers a creative solution to this issue. The technique uses RFID tags attached to the ambulances and detectors at traffic signals to prioritize the flow of the vehicles. The RFID system is used in conjunction with traffic lights to create "green corridor," that allowing ambulances to drive through without stopping as they approach, reducing delays and ensuring faster entry to hospitals. Real-time communication is made possible by the system's incorporation of RFID technology, which makes precise traffic light regulation possible. Switching lanes dynamically as necessary not only improves helping to maintain overall traffic flow while boosting the efficacy of emergency response by dynamically switching lanes as needed. In addition, RFID-based systems may be expanded and adjusted to work with various emergency vehicles as needed, making them suitable for usage in urban settings. Even though the initial infrastructure deployment may create difficulties like cost and technological concerns, the long-term benefits of improving traffic control and speeding up ambulance response times make it a desirable achievement in urban planning and healthcare.

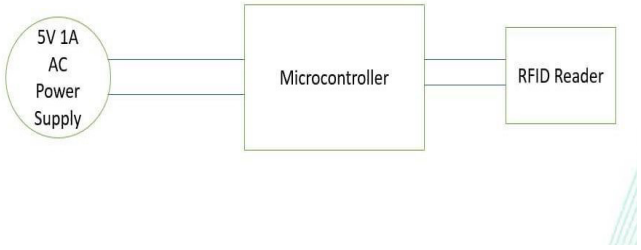


Figure 1. Block diagram of the system[3].

Figure 1 represents a basic setup for a Smart Traffic Control System for Ambulances using RFID technology. In this setup a 5V 1A AC power supply provides the necessary power to run the microcontroller and other connected components in the system. The microcontroller acts as the central unit of the system. It processes data received from the RFID reader and communicates with other devices in the traffic control system. When an ambulance approaches an intersection, the RFID reader identifies the ambulance, and the microcontroller processes this information to control traffic signals, giving priority to the ambulance. The RFID reader is used to detect the presence of an ambulance equipped with an RFID tag. When the ambulance is in proximity, the RFID reader reads the tag and sends this information to the microcontroller. This helps identify the ambulance and trigger the traffic control mechanism. In the context of smart traffic control, this setup enables automatic detection of ambulances and adjusts traffic signals in real time to ensure a clear path, thereby reducing delays and improving emergency response times. The RFID reader is connected to the microcontroller, which is programmed to recognize and authenticate specific RFID tags on emergency vehicles. The remote control is connected wirelessly to the microcontroller, allowing the driver to activate the signal override. When the RFID reader detects an authorized tag, it sends an electrical signal to the microcontroller. If the remote control is activated by the driver, the microcontroller then sends a signal to the traffic light controller, instructing it to change the light to green for the designated time. The circuit is powered by a stable DC supply to ensure reliable operation of all components. By providing emergency vehicles priority at crossings, the RFID-based Intelligent Traffic Management System aims to optimize traffic flow. The system uses RFID technology to automate traffic regulation, which

lowers delays and improves public safety. Architecture and purpose of the system RFID tags are attached to emergency vehicles to provide a unique identity. At traffic junctions, RFID readers are placed to identify approaching emergency vehicles. Traffic signal controller: Provides an obvious route by automatically adjusting traffic lights in response to RFID detection. A centralized monitoring system allows for easier to connect systems and control traffic in real time.

4.0 Conclusion

In several countries, social growth and economic recovery are being aided by a recent mining boom. RFID technology is emerging as the next big thing in the mining industry at the perfect time. The collection and exchange of real-time data among mining investors, the creation of innovative business models, and the use of strategies tactics are all expected to be altered by RFID technology. The mining industry uses Radio-Frequency Identification (RFID) for a variety of tasks, including monitoring Personal Protective Equipment (PPE), regulating workers access to mining sites, and tracking explosives. In conclusion, PPE is required for workers in mining industry. PPE typically includes steel-toed boots, gloves, safety vests, hardhats, eye protection, masks, earplugs, and other items. Different job situations require different PPE, which must be used in accordance with norms and regulations. One way to address this issue and establish a safe working environment for mining employees is to implement RFID technology. Every piece of personal protective equipment (PPE) needs to have an RFID tag attached in order to be controlled. RFID works by using an RFID reader or an antenna system to detect when a person wearing Personal Protective Equipment (PPE) equipped with RFID tags passes through the gate. The RFID tag might provide important details about the PPE the employee has been wearing. Before an individual begins working, this method ensures that they are wearing the necessary and required PPE components.

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