International Journal of Emerging Research in Engineering and Technology
Pearl Blue Research Group| Volume 6 Issue 3 PP 86-94, 2025
ISSN: 3050-922X | https://doi.org/10.63282/3050-922X.IJERET-V6I3P110

Original Article

A Review of RFID Technology's Impact on Inventory Management and Supply Chain Optimization

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Received On: 28/06/2025 Revised On: 15/07/2025 Accepted On: 20/08/2025 Published On: 01/09/2025

Abstract - *The use of Radio Frequency Identification (RFID) technology is essential to the modernization of supply chain and inventory management systems as it enables precise, automated tracking in real time. This technology makes supply chain networks more transparent from start to finish, improves operational efficiency, and reduces human error through wireless communication between RFID tags and readers. Its capacity to gather and transmit data in real-time helps companies optimize inventory levels, make educated decisions, and increase customer satisfaction. This review explores the key components of RFID, including tags, readers, antennas, and middleware, and highlights their functions in managing inventory and logistics. Applications in real-time tracking, error reduction, warehouse automation, and integration with ERP and IoT systems are examined. The paper also reviews multiple studies comparing RFID with traditional barcoding systems, revealing RFID's superior performance in cost reduction, accuracy, and user experience. Furthermore, critical issues such as cybersecurity, system complexity, and integration challenges are discussed. The literature collectively demonstrates RFID's potential to revolutionize supply chains through increased transparency, data-driven decision-making, and process efficiency. The study concludes by outlining current limitations and suggesting directions for future research to enhance RFID adoption and performance in evolving digital supply chains.*

Keywords - *RFID, Inventory Management, Supply Chain Optimization, Real-Time Tracking, Automation, Barcode Comparison, Warehouse Systems.*

1. Introduction

In today's highly competitive and globalized market, supply chains are no longer perceived merely as cost centres, but rather as strategic assets that contribute to sustainable competitive advantage. Organizations are increasingly realizing that it is not individual companies, but rather their supply chains, that compete against each other [1]. Customers now demand higher transparency and real-time visibility regarding product origin and quality. Thus, a crucial element of contemporary SCM is the capacity to monitor the movement of parts and goods along the value chain.

RFID technology has become a potent instrument to meet these changing needs. A reader sends signals to a tag using RFID, a non-contact data transmission technology, and the tag responds [2]. RFID has been utilized in various sectors, including healthcare, fashion, logistics, retail, and construction, since its development during World War II to identify aircraft on radar.

An essential duty for every firm is inventory management. In addition to monitoring the quantity of inventory products, it involves managing the flow of inventory into and out of the business. Traditional inventory control techniques are often manual and labor-intensive. It may also be erroneous, which might result in missed sales and stockouts. One of the main responsibilities of every company that handles tangible commodities is inventory management, and RFID is crucial to this process [3]. Optimal stock levels, reduced carrying costs, and avoided stockouts are the goals of inventory management. However, traditional inventory systems often struggle with manual data entry, human errors, time-consuming audits, and a lack of real-time visibility. The integration of RFID into inventory systems addresses these limitations by enabling automated, real-time tracking of inventory movements [4]. It minimizes manual intervention, reduces operational inefficiencies, and enhances decision-making accuracy [5].

Furthermore, RFID acts as a digital enabler in supply chain optimization, supporting activities such as warehousing, packaging, order fulfilment, and distribution [6][7]. RFID systems continuously generate and provide real-time data that can be examined to obtain insights on operations. These insights help organizations enhance product traceability, ensure quality assurance, and strengthen their competitive positioning [8].

An integration of RFID with the IoT has further transformed the logistics landscape. RFID-IoT systems provide seamless interconnectivity, enabling various supply chain components to communicate and operate in a synchronized manner [9]. The proper items are supplied in the appropriate amount, on time, and to the right place because to these technologies' transparency, scalability, and adaptability [10][11]. Additionally, RFID-IoT contributes to substantial reductions in supply chain management (SCM) costs and boosts overall process efficiency.

1.1. Structure of the Paper

The structure of this paper is as follows: Section II provides an overview of RFID technology and its key components. Section III delves into the many ways RFID may be used for inventory management, including topics like automation and real-time tracking. The function of RFID in optimizing the supply chain is discussed in Section IV. Section V presents a literature review of recent studies. The article is wrapped up and offers suggestions for further study in Section VI.

2. Fundamentals of RFID Technology

There is a class of technology known as AIDC devices to which RFID systems belong. RFID is a wireless communication system that allows computers to remotely read the unique characteristics of inexpensive electronic tags [12]. The core principle of the technology is the transmission of radio waves or signals between two entities, in this case, a tag and a reader. Therefore, it is considered a technology that facilitates. Researchers have been flocking to study RFID phenomena, drawn in by the technology's promising future applications. Figure 1 illustrates the RFID System.

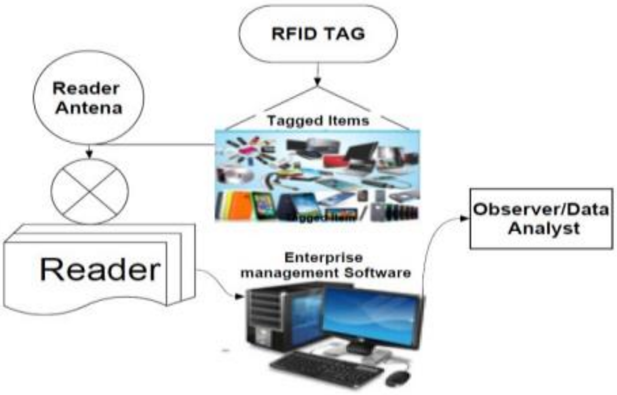

Fig 1: RFID System

2.1. Key components of RFID Technology

Antennas and integrated circuits are the building blocks of RFID. An RFID tag and an RFID reader make up the majority of it. RFID tags that connect with an interrogator, also known as an RFID reader, consist of two parts: an antenna and an integrated circuit (IC) [13][14]. After that, this reader transforms the radio waves into more useful data. Following data collection from RFID tags, a communications interface transmits the collected information to a host computer system. For later use, the data may subsequently be stored in a database. The picture below displays the data.

- **RFID Tag:** The kind of asset and its planned usage will determine whether the RFID tags, also called transponder units, are passive or active. It is common practice to charge the batteries and beacons included in active RFID tags on a regular basis. A few hundred feet may be enough distance to remotely read the RFID tags, subject to surrounding noise and the kind and power of the antenna. Passive RFID tags get power when they are within signal range of the reader. Due to their much cheaper cost compared to active RFID tags, it has a noticeably shorter read range. Radio waves are used by RFID tags, which are electronic tags, to connect to RFID readers. RFID tags has been shown in Figure 2.

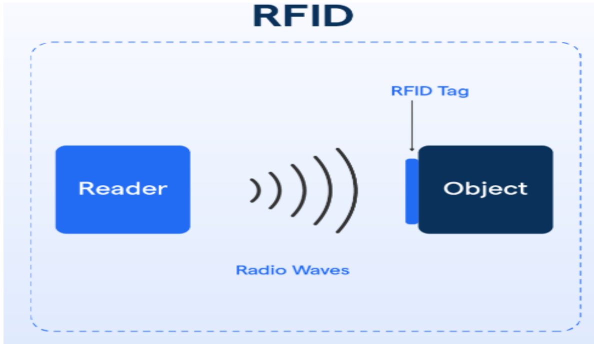

Fig 2: Radio Frequency Identification (RFID) Tags

- **RFID Reader:** An RFID reader is required for any RFID system to function. The brain of the system is it. By exchanging radio waves, readers, also referred to as interrogators, connect to RFID tags. One way to access information stored in RFID systems is via a radio frequency identification reader. In order to transmit information from an RFID tag to a reader, the system makes use of radio waves. Figure 3 shows an RFID reader.

Fig 3: Radio Frequency Identification (RFID) Reader

- **RFID Antenna Works:** An antenna for scanning, an RFID tag that contains all of a product's data, and a reader that usually reads, decodes, and analyzes the data from the tag are the three primary parts of an RFID system. Together, these three elements first store the data on the RFID tag in a read-only or read-write format. The RFID tag is powered by either passive operation or a battery. The RFID tag will start sending data in the form of radio waves as soon as it comes into contact with the scanning antenna because of electromagnetic (EM) energy. The reader receives these radio waves when the antenna detects them and decodes them into digital data. Figure 4 illustrates how the RFID Antenna operates.

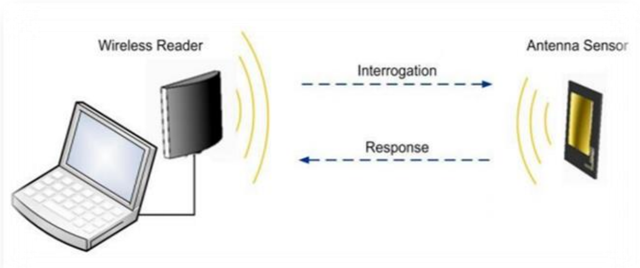

Fig 4: Radio Frequency Identification Antenna Works

- **RFID Middleware:** The RFID software acts as a go-between for scanners and applications used by large corporations [15]. The RFID software acts as a go-between for scanners and applications used by large corporations. Middleware software is responsible for more than simply managing RFID readers and printers and connecting them to enterprise applications; it also filters, preserves, collects, and interprets the data retrieved from RFID tags. Figure 5 displays radio frequency identification middleware.

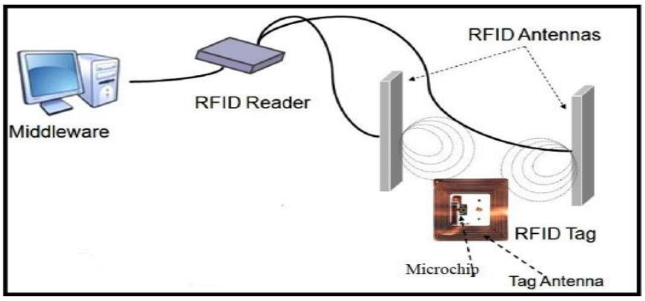

Fig 5: How the Radio Frequency Identification Middleware

2.2. Types of RFID

There are some types of Radio frequency identification discuss below:

2.2.1. Passive RFID

As the name indicates, a passive RFID tag is one that does not have an integrated radio frequency transmitter or battery. In order for a passive tag to transmit the data stored in its memory, it must be powered by an electromagnetic wave that originates from an interrogator, such as an RFID reader and antenna. This wave powers the embedded electronic circuit, also known as the chip.

2.2.2. Semi-Passive RFID

The term "battery-assisted passive" (BAP) describes an RFID tag that is partially passive and has its own power source. The communication concept is identical to that of the passive RFID tag, therefore there's no need to utilize the power source to power an RF transmitter. The energy is used to power various sensors that are attached to the RFID chip, such as those that measure temperature, current, acceleration, gyroscope, etc., or the tag's electrical circuit (the tag's activation is no longer dependent on distant powering via the reader, allowing for increased reading distances). The replacement of batteries is an essential component of these tags' maintenance schedule.

2.2.3. Active RFID

A power source (batteries) is included into an active RFID tag together with an RF transmitter. Similar to semi-active tags, it may incorporate an extra microcontroller to assure its own signal processing and be fitted with sensors. Because of its battery, this tag is able to communicate with its surroundings on its own by communicating its location, measuring temperature, and more [16]. It also need maintenance, such as battery replacement, more often than semi-active tags.

2.2.4. Technical Challenges in RFID Applications

The following characteristics mostly indicate the difficulty of initializing the implementation of RFID [17][18]:

- **Technical complexity:** RFID technologies are more intricate than older bar code methods. When using RFID technology for the first time, it's important to have the right technical teams on board to make sure everything is set up and running well.
- **Data Integration:** To incorporate RFID technology into existing systems for managing the supply chain, it may be necessary to do some data integration work. This includes making sure that RFID systems can communicate with one other and that data may flow freely across current systems.
- **Adjustments during transition:** Some operational modifications and issues may arise during the first operation. In order to guarantee a seamless integration of RFID technology into the apparel industry's business process, the team must promptly address this issue.
- **Technology:** The radio frequency theory that RFID is based on makes it susceptible to interference from other radio signals, metals, liquids, and so forth. How much interference there is, which might cause erroneous reading, depends on the tag's frequency and the use context. Items bought at checkout counters can have their price tags read by RFID scanners, however the radio waves from other objects might interfere with them. The products may come in various packaging according to their origins in different countries [19].
- **A lack of uniformity:** There are still many challenges to be solved in frequency identification, which is in its early stages. A wide variety of RFID standards, each with its own unique set of requirements for scanners and software, are in use today. Consequently, for manufacturers, retailers, and distributors to collaborate, a frequency (or frequencies) must be agreed upon by all parties involved.

3. Applications of RFID in Inventory Management

Managing inventory is a crucial part of any business's decision-making process because it ensures that all items in stock are treated with the utmost care. This covers the actions, rules, and guidelines implemented to control inventory and maintain constant track of the amount of each item in the warehouse [20]. The goal of inventory management is to keep stock levels under control, monitor sales, and restock as needed to fulfil client demand. Maintaining and making accessible a company's resources is the responsibility of inventory management. Good inventory management ensures that there will never be a scarcity of goods and that deliveries will always be on schedule.

RFID technology allows for the automated radio-wave identification of persons, animals, and things. Using RFID tags, businesses can monitor the flow of consumers and their purchases, which improves logistics, inventory management, and the organization of in-store and online customer flows and visits [21][22]. The three primary domains of business analytics are as follows: The practice of predicting future product demand using past sales data is known as demand forecasting, inventory management (the science of making warehouse inventory levels optimal based on historical sales data and product movement), and offer personalization (the art of making personalized offers based on customer preferences and purchases).

3.1. Real-Time Inventory Tracking and Automation

As a result of using RFID, operational flexibility was enhanced, and inventory management expenses were decreased. To lessen the likelihood of inaccurate inventory records, a system for managing stock using radio frequency identification tags in conjunction with the Zigbee wireless network can identify the goods' real-time whereabouts. The inventory management software reveals the precise whereabouts of an item by referencing the shelves, columns, and rows. Applying the technology to larger-scale logistics monitoring and management tasks is a good fit [13][23].

The information obtained from the load cells positioned underneath the shelves is used to monitor the cost and pace of product depletion. RFID tags are also used by the system to identify the products that are put in different shelf sections. An Android app may be used to track the inventories. A shopping cart-based solution that makes it possible to automate the purchasing process. The technology can identify items in a shopping cart or basket by using a camera in conjunction with a pretrained neural network. In order to authenticate the weight of the items in the cart, a load cell is used. Quite a similar setup, but with load cells integrated into the shopping cart and using a Raspberry Pi and RFID tags instead. The load cell checks the product weights against the RFID tags to verify whether the correct item has been added to the cart, and if so, the system notifies the user.

3.2. Reduction in Errors and Manual Workload

RFID tags provide many benefits for inventory management, including faster scanning and reduced labor costs. Below is an illustration of how RFID tags may be used to control inventories. It can be read in any direction, providing more insight into the stock, and may even allow for more regular updates and scanning at different places [24][25]. Given that labor expenses make up as much as 50-80% of distribution center expenditures, RFID might be helpful in this context. Counting, shipping verification, and inventory check-in can all be completed automatically with a few scans, eliminating the need for multiple workers to handle them.

3.3. Case Example of a Warehouse Management System

An RFID inventory management system is being considered for a distribution center's planned automated warehousing system. This system would have a portal gate that could concurrently scan incoming and outgoing RFID-tagged items. An RFID reader is included into every AS/RR pusher; this reader facilitates communication with a local controller, which in turn talks with a middleware to send the gathered data to a central warehouse database. Through software translation, the middleware serves as a link between an RFID reader and a business system. If a consumer places an online order for an item that is physically located in the store, the warehouse database will be checked for availability after notifying the RFID inventory management system. Data gathered in real-time by RFID readers connected to an iWLAN via the controller is stored in the database [26]. A warehouse's SKU number, a distinct identifier, and a description of each requested item are all part of the data gathered. The programmable logic controller (PLC) controls a pusher to transfer the tote containing the requested item from the RFID-inventory management system to an output conveyor as soon as it is recognised. The item will thereafter be led along a predetermined path to a designated location (the collecting point) for packing by means of the output conveyor [27]. Upon clearance from the distribution center via the RFID-reader-equipped gate, the warehouse's RFID-inventory database will be updated accordingly. Figure 6 shows the RFID system for managing inventories.

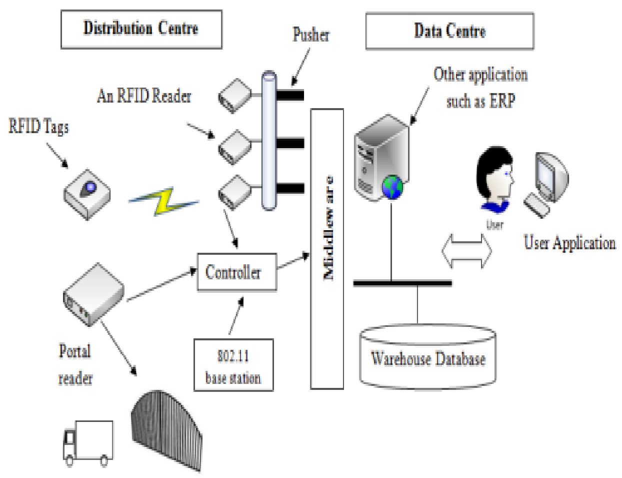

Fig 6: The RFID Inventory Management System

3.4. Impacts of RFID Technology on Inventory Management

The advent of RFID technology has revolutionized inventory management, which makes data-driven decision-making, real-time tracking, and automation possible [28]. The primary impacts of RFID on inventory management include the following:

- **Real-Time Inventory Visibility:** RFID systems provide continuous, automated tracking of inventory items, allowing organizations to monitor stock levels, item locations, and movement within warehouses. This real-time visibility minimizes the risk of stockouts or overstocking and supports more efficient replenishment strategies.
- **Reduced Human Errors and Labor Costs**: Conventional inventory management techniques mostly depend on labor-intensive, error-prone

human data entry and barcode scanning. RFID automates data collection, reduces the need for manual checks, and accelerates the inventory counting process, thereby lowering labor costs and enhancing data accuracy.

- **Enhanced Accuracy and Traceability:** RFID enhances traceability by providing item-level information, including origin, manufacturing date, and current location. This improves quality control, ensures product authenticity, and supports efficient recall processes when needed.
- **Increased Operational Efficiency:** By streamlining inventory audits, receiving, and shipping processes, RFID reduces operational delays and improves throughput. Automated systems can process inventory transactions in bulk, saving time and increasing productivity.
- **Improved Demand Forecasting and Inventory Planning:** It is possible to evaluate the data gathered by RFID devices to find trends and patterns in the movement of products. This information enables organizations to forecast demand more accurately and optimize inventory planning, thereby reducing carrying costs and excess stock.

4. RFID in Supply Chain Optimization

The integration of RFID into SCM is vital because it allows for the transfer of data from physical locations to digital ones, which is especially useful for large companies [29]. For instance, operational efficiency and competitive advantage may be boosted by implementing a framework for RFID development.

4.1. End-to-End Visibility and Transparency

Efficiency, risk management, and stakeholder and consumer trust are all greatly aided by visibility and openness in today's complicated and worldwide supply chains. As a result, businesses are better equipped to deal with disruptions, stay in compliance with laws, and satisfy the increasing demand from consumers for sustainable and ethical business operations.

RFID is one example of a sensor-based technology that has found widespread use across several sectors, including retail, and enables the gathering of data in real time. The results of the pilot study on warehouse operations suggested that RFID may enhance performance in a number of areas, including shipping and receiving. According to their estimates, end-to-end visibility might be improved by incorporating RFID into bigger supply chains [30]. Automated identification and tracking of assets, items, and commodities along the supply chain is a major use case for RFID technology.

4.2. Improved Logistics and Delivery Accuracy

Logistics is a component of SCM, a strategy that combines manufacturers, suppliers, warehouses, and retailers to distribute the generated items in the ideal amount, time, and place while reducing total costs and enhancing customer experience. Logistics is the study of moving commodities from their place of origin to their final destination in a way that satisfies the needs of the customer in terms of kind, quantity, time, and location [31][32][33]. RFID has been widely used in logistics, as shown by a number of earlier studies. This system is ideal for tracking and discarding items. RFID technology has several applications in logistics, such as manufacturing, retail, inventory control, warehouse management, and commodities transportation [34]. A better performance in logistics and SCM is the main objective of using RFID technology.

4.3. Integration with Supply Chain Management Systems

SCM relies heavily on RFID and the IoT to track the whereabouts of products, inventory, machinery, and employees. Online communication channels may be set up and trustworthy data can be automatically identified with the help of these technologies. RFID-IoT enables customers to monitor all manufacturing stages and get quick, relevant feedback regardless of what is going on. The supply chain becomes much more efficient as a consequence, reducing losses and unnecessary expenditure. A major issue in SCM is the inability to integrate and combine the activities completed at each level, which makes it impossible to precisely estimate time and money spent [35][18][8]. For this problem, Automatic intra- and interconnection of machinery, processes, stages, and the surrounding environment is made possible by RFID-IoT. This technology makes it possible for data to be sent over the internet with ease, which increases supply chain transparency and streamlines workflow.

4.4. Integration with ERP

E-Resource Planning (ERP) and RFID technologies are part of the technological evolution of SCM. As a result of technological advancements, this adjustment is now standard practice in SCM. Businesses may improve supply chain visibility and transparency, pinpoint bottlenecks, and react to changes in the market with more accuracy and speed after using ERP and RFID [36]. Therefore, in this digital age, improving SCM's efficiency and resilience requires using ERP and RFID.

5. Literature of Review

This section reviews RFID applications in inventory and SCM, focusing on real-time tracking, automation, system efficiency, security concerns, and comparisons with barcode systems to highlight RFID's operational and economic advantages.

T M et al. (2025) RFID-based tracking, GPS integration, clustering techniques, and IoT applications in logistics is presented, highlighting their capabilities, limitations, and future potential. As part of the project’s initial implementation, a prototype was developed using an Arduino-based RFID system that links unique order IDs to RFID tags. This low-cost and scalable solution demonstrates how emerging technologies can be harnessed to automate parcel identification and streamline tracking processes. The study underscores the transformative potential of such a system to reduce delays, enhance resource optimization, and provide unparalleled real-time visibility, setting the stage for a further efficient and reliable global supply chain [37].

Ali et al. (2024) mainly deals with an ideal smart sensors and RFID system to cater suitable asset solutions and supply chain tracking. Due to the benefits shown, the following were accomplished: First, there will be an enhancement of the accuracy of records of inventory; second, there will be a diminution of time taken to complete an order cycle; third, there will be a decrease in costs. Overall compliance rate to environmental monitoring also increased attaining a very good figure in order to achieve the right monitoring standards for the sensitive goods as described above. The system also complemented the issue of security to some extent in reducing cases of theft and losing products within the unit. It also reveals a unique trend of ROI which expands how the utilization of value technologies is rewarding financially [38].

Ton et al. (2024) use of Barcode technology in inventory management, many noticed the drawbacks that come with manual labor and the inaccuracy of inventory control due to lack of real-time visibility. Many companies and manufacturers have considered the use of RFID to counter the drawbacks of using Barcode technology for these reasons. In the research paper, they develop models of managing inventory through RFID and Barcode by simulating them in ARENA and comparing them against each other based on customer satisfaction, average inventory level, and total cost with a case study of a supermarket in Ho Chi Minh City. The results show that the RFID model, ran in the span of one year, is more beneficial than Barcode with a decrease in an average inventory level of 13.37%, the total cost is down by 15.7%, and customer satisfaction is improved by 1.38% [39].

Ali et al. (2024) provide an Internet of Things (IoT)-based solution for inventory management in warehouses that uses RFID technology and the Firebase cloud platform to totally transform existing warehouse management procedures. Incorporating these technologies allows the system to overcome the drawbacks of conventional warehouse management systems by synchronizing data in real-time, automating inventory monitoring, and improving visibility. This system is a strong option for many sectors since it increases scalability, inventory accuracy, and operational efficiency [40].

Cummins et al. (2024) presents an experimental design using three commercially available UHF RFID tags, which their manufacturers claim is designed for small products in the healthcare and pharmaceutical sectors. The tags were tested on two control samples and four liquid suspension over-the-counter drug formulations. This study aimed to investigate the correlation between the pH and conductivity of these products and the performance of RFID tags, including tag sensitivity and theoretical read range, with the ultimate objective of enhancing RFID efficiency in asset management systems [41].

Subramanian et al. (2023) investigate blockchain's possible use in the food delivery system to increase transparency and accountability in particular the supply chains for dairy products, crops, and fisheries. These supply networks are associated with a number of issues, including food safety, sustainability, and labor practices. This paper offers three distinct blockchain-based ways to tackle these issues. A model framework for tracing the movement of dairy products along the supply chain is initially presented. Additionally, a theoretical framework is put out for an agricultural food supply chain system that utilizes blockchain technology. A blockchain-based solution to enhance accountability and traceability in the fish supply chain is presented at the end of the article [42].

Zhang (2022) research the development of an RFID-based intelligent logistics software for managing warehouse operations. In the first part, it explains how intelligent distributed control nodes and RFID technology came to be. Then, it gives a quick rundown of the main parts of an RFID system, explains how it works, and then breaks down the needs. The second step is to introduce the ALOHA time slot algorithm and build the system's general architecture. The last step in developing a warehouse management system is to study and plan its inventory and warehouse modules [43].

Kafi et al. (2022) identifies barcode as the primary instrument in supply chain management (SCM) research from the 1970s forward. More and more sectors are looking at ways to save money by using RFID systems. The technological aspects and supply chain consequences of RFID are laid forth in this research. Additionally, the report emphasizes the benefits of inventory control and administration, which help organizations comprehend how RFID offers full services while saving money. Therefore, investigations in this field may use this publication as a resource [44].

Table I presents a summary of the literature review, highlighting each study's focus, approach, key findings, challenges, and proposed future directions.

Table 1: Comparative Analysis of literature review on RFID Technology's impact on Inventory Management and Supply Chain Optimization

Reference	Study On	Approach	Key Findings	Challenges	Future Direction
M. et al. (2025)	RFID, GPS, IoT in logistics	Arduino-based RFID prototype with unique order IDs	Low-cost, scalable solution; improved tracking and visibility	Integration complexity in large-scale operations	Scale prototype to industry-wide deployment with real-time analytics
Ali et al. (2024)	Smart sensors and RFID in	Smart RFID system for asset	Improved inventory accuracy, order cycle	Handling sensitive goods and ensuring	Enhance system for broader asset types

	supply chain	tracking	time, and cost savings; better environmental compliance and theft reduction	data accuracy	and environmental conditions
Ton et al. (2024)	RFID vs. Barcode in inventory	ARENA simulation comparing Barcode and RFID	RFID reduced inventory levels by 13.37%, cost by 15.7%, and improved satisfaction	Cost of implementation and training	Broader simulation across different retail sectors
Ali et al. (2024)	IoT-based warehouse management	RFID + Firebase Cloud for inventory tracking	Real-time sync, automated tracking, and improved scalability	Dependence on stable internet and cloud service	Integrate AI for predictive restocking and fault detection
Cummins et al. (2024)	RFID tag performance in pharma	Testing UHF RFID tags with drug formulations	Performance influenced by pH and conductivity; better understanding of tag behavior	Limited to specific healthcare products	Expand study across more chemical compositions and tag types
Subramanian et al. (2023)	Blockchain in food supply chain	Blockchain-based frameworks for dairy, agriculture, seafood	Improved traceability, accountability, and food safety	Complex implementation across diverse supply chains	Real-world pilot testing and integration with IoT/AI
Zhang (2022)	Intelligent logistics warehouse	RFID with ALOHA time-slot algorithm	Efficient warehouse and inventory design	Collision handling in RFID communication	Optimize algorithm and integrate with AGV systems
Kafi et al. (2022)	RFID vs. Barcode in SCM	Comparative study of RFID technical benefits	RFID offers better cost-saving and comprehensive inventory control	High initial cost and infrastructure needs	Development of hybrid systems and low-cost RFID solutions

6. Conclusion and Future Work

RFID technology on inventory management and supply chain optimization. RFID has proven to be a powerful enabler of automation, accuracy, and real-time visibility across logistics, warehousing, and retail environments. The technology's core components—including RFID tags, readers, antennas, and middleware—work cohesively to streamline inventory tracking, reduce manual interventions, and enhance data reliability. In inventory management, RFID reduces stock discrepancies, improves replenishment processes, and supports demand forecasting. In the broader supply chain context, RFID enhances transparency, delivery accuracy, and interoperability through integration with ERP and IoT platforms. Despite technical challenges such as frequency interference, integration complexity, and a lack of standardization, RFID continues to gain traction due to its tangible benefits in operational efficiency and cost savings.

The future of RFID technology lies in its integration with emerging digital innovations to unlock new dimensions of smart inventory and supply chain systems. The use of Blockchain can enhance security, traceability, and authenticity across global supply chains. With the advent of 5G and edge computing, RFID systems are expected to become faster, more scalable, and responsive. Furthermore, the adoption of energy-harvesting technologies could address the limitations of batteries in active and semi-passive RFID tags. Future studies should concentrate on resolving interoperability issues, establishing international standards, and producing reasonably priced RFID systems for small and medium-sized businesses. As these advancements unfold, RFID is poised to become a cornerstone of next-generation inventory and supply chain ecosystems.

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