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Enhancing supply chain performance using RFID technology and decision support systems in the industry 4.0–A systematic literature review

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ABSTRACT

Supply Chain processes are continuously marred by myriad factors including varying demands, changing routes, major disruptions, and compliance issues. Therefore, supply chains require monitoring and ongoing optimization. Data science uses real-time data to provide analytical insights, leading to automation and improved decision making. RFID is an ideal technology to source big data, particularly in supply chains, because RFID tags are consumed across supply chain process, which includes scanning raw materials, completing products, transporting goods, and storing products, with accuracy and speed. This study carries out a systematic literature review of research articles published during the timeline (2000-2021) that discuss the role of RFID technology in developing decision support systems that optimize supply chains in light of Industry 4.0. Furthermore, the study offers recommendations on operational efficiency of supply chains while reducing the costs of implementing the RFID technology. The core contribution of this paper is its analysis and evaluation of various RFID implementation methods in supply chains with the aim of saving time effectively and achieving cost efficiencies.

1. Introduction

Effective supply chains form the heart of the modern-day economy. This is evident in the popularity and success of Amazon and XPO Logistics. These companies have each developed a competitive advantage by using modern technologies within their supply chains to support strategic and operational decisions. Supply chains are continuously challenged by varying demands from customers, rapid and unpredictable changes to supply routes, major uncontrollable disruptions (e.g. the COVID-19 pandemic and ensuing lockdowns) and legal and compliance issues associated with cross-border goods movements. Enterprises systems associated with data science and Industry 4.0 enabled technologies that has the potential to augment sustainable performance and cost reduction across supply chains (Munoz-Ausecha et al., 2021). Data science is applied to supply chains for sourcing, storing, cleaning, and analyzing vast amounts of mostly real-time data. Radio Frequency Identification Device (RFID) technology has the potential to generate voluminous real time data, streamed data that can be invaluable in optimizing supply chains. RFID has experienced significant adoption across industries in recent years (Wamba et al., 2013). RFID sensors can provide significant real-time data to monitor inventory levels and identify, track, and ensure the security of goods (Zhang & Wang, 2018).

An RFID system is represented in Fig. 1. This system comprises major objects including: reader, reading-tags and final servers applied to real-time data tracking for multiple applications. In the previous researches studied by us, Shiraishi et al. (2008) discussed UHF RFID based on indoor estimation. Wang et al. (2013) explained RFID positioning indoor tracking mechanism. The study by Zhu et al. (2020) explained the usage of RFID technology for similar purposes. RFID is a digital enabler, complemented by unified standards across industries, high compatibility with IT infrastructure, ease of use, and interoperability among functional areas that help businesses evolve as digital entities (Deepu & Ravi, 2021; Kamble et al., 2019). RFID helps to digitize supply chains as the technology generates automated sensor data that can be further analyzed for automation and optimization. RFID technology functions by identifying the presence of an object, recording the data, and

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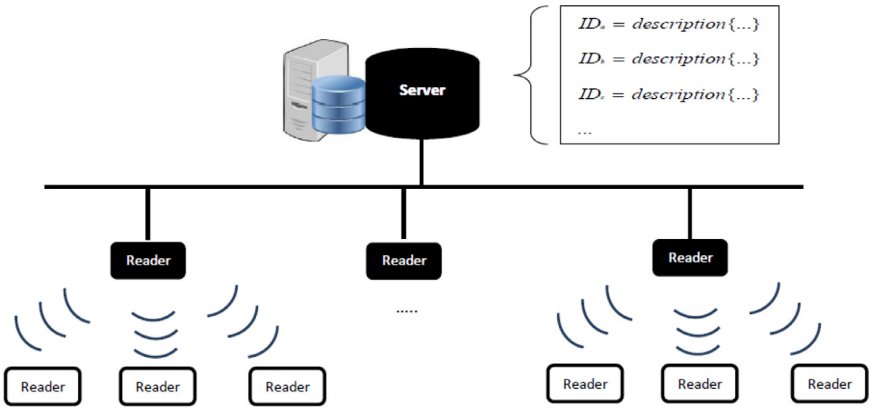

Fig. 1. Generalized RFID layout.

Table 1
Search criteria.

Search Terms	Initial Search	First Screening	Second Screening	Third Screening	Fourth Screening
"Supply Chain Performance" AND "Decision Support System" AND "RFID Technology"	22	19	17	12	6
"Supply Chain Management" AND "Decision Support System" AND "RFID Technology	29	18	12	8	4
"Supply Chain Performance" AND "Decision Support System" AND "Industry 4.0"	22	18	15	14	3
"RFID Technology" AND "Industry 4.0" AND "Decision Support System"	23	12	8	6	4
"RFID Technology" AND "Industry 4.0" AND "Information Management"	42	22	18	12	8

storing that information (Musa et al., 2016). Analyzing data stored in the system leads to data-driven insights, which inform decision making in optimisation (Fanti et al., 2017). RFID can improve inventory levels, tighten delivery routes, and enrich the customer experience by offering real-time data that improves overall efficiency and accuracy (Choi et al., 2017).

RFID is applied in several industries including retail, financial, and consumer goods in order to improve various functional areas such as sales, returns, and inventory management, resulting in increased overall productivity (Eksiouglu, 2014; Sharma et al., 2020a, 2020c). Due to high returns on investments (ROI), business organizations drive RFID implementations. Industrial usage of RFID has improved performance by reducing stock levels, response time, and reordering capabilities (Zhang & Wang, 2018; Ding et al., 2021). Visibility and transparency in supply chains increase throughput record accuracy, order fulfillment, improved quality, and collaboration (Delen et al., 2007). Data-driven self-monitoring mechanisms also provide human-free inventory control, check-outs, and compliances. Supply chain performance is improved through collaborative order fulfillment across the industry (Luthra et al., 2022; Sharma et al., 2021). Implementation requires significant investments on part of the business based on strategic considerations of processes and people. For example, supply chain managers need to be trained as informed consumers of RFID-based data generation and analytics (Batta et al., 2020; Joshi & Sharma, 2021). The literature is limited in exploring RFID role in supply chain optimization; hence this study has addressed this gap. This study also explores the use of RFID-generated streaming data in AI-based systems for ongoing monitoring and optimization of supply chains.

The research study has two objectives: (1) To evaluate key processes in supply chains to understand their challenges and value to the business and; (2) To explore RFID technology adoption and implementation to optimize supply chains. This present work discusses value addition due to RFID technologies in optimizing supply chains. This study has the potential to impact supply chain efficiencies, reliability, and resilience.

The study is arranged as follows: Section 2 explains the research literature on RFID adoption Section 3 introduces applications of RFID for optimization purposes, Section 4 discusses results and findings and the last section explained the conclusion.

2. Literature review

A systematic literature review is undertaken identify and evaluated past works related to RFID and supply chains, published from 2000 to 2021 using SCOPUS database. Table 1 exhibits the search patterns used for secondary literature review.

The initial search resulted in 138 articles. After eliminating the duplicates, the list of articles came down to 89. When this list was narrowed down to journal articles only, it resulted in 70 articles. A quick read of these articles resulted in the exclusion of those not directly related to our study, resulting in retention of 52 articles. Finally, after detailed reading of the abstracts and contents, we shortlisted 25 articles for further rigorous study. Factors were identified from the selected papers. The following section discusses the detailed elaboration of the applications of RFID in the regime of Industry 4.0 to enhance supply chain operational performance and information management across the system.

2.1. RFID technology and supply chain management (SCM)

Existing research on RFID continues to grow exponentially (Badia-Melis et al., 2018; Fanti et al., 2017). The literature includes its applications in supply chain management. As a digital technology enabler, RFID is a competitive tool in managing supply chains and provides significant research interest across a range of activities, including warehousing, packaging, processing, and distribution across value chains (Delaunay et al., 2007; Chanchaichujit et al., 2020; Paul et al., 2022). RFID enables the generation and ingestion of real-time data. Analyzing this data produces insights that enable the effective identification, tracking, and traceability of inventory in supply chains, resulting in greater efficiency and building of a sustainable competitive advantage through product quality assurance (Chanchaichujit et al., 2020; Liang et al., 2021). RFID technology comprises a reader and a tag to identify objects through radio waves. The tag receives information from an object and then transmits it to the reader. RFID automates continuous replenishment or vendor-managed inventories. Tags are used to identify and track objects. The readers record the tag information and send the data to a server for analytics through software interfaces. Tags comprise an IC chip, an antenna, and its assembly process. Typical RFID tags range

in price from $0.30 to $0.90 USD (Chen et al., 2017). Tags are becoming ubiquitous thanks to the rapid drop in the price of IC chips and less expensive assembly processes. RFID supports more than 30 billion devices and RFID engagement enhances the communication among various functional areas, at both the intra- and inter-firm levels (Table 6).

Chipless RFID, which do not require microchips in their transponder, have emerged. Instead, chipless RFID uses a technology that multiplies the radio waves on the shiny surface of a crystal. This is considered a Nano-technology genre (Lu et al., 2017). A passive tag is simple, cheap and needs no internal power source. Passive tags are the conventional method for tracking products. There is an alternative to passive tags called Ultra High Frequency (UHF) tags. The UHF tags follow the Gen-C protocol (Generation 2, Class 1) that is approved by ISO 18,000 – 4C (Chen et al., 2017). The schemes are segregated into two types: pure Additive Links On-line Hawaii Area (ALOHA) and slotted (ALOHA) (Abramson, 1970). Its algorithm aims to reduce collision and uses Time Division Multiple Access. Based on research findings and feasibility, pure ALOHA has now become generalized (Chen et al., 2017; Liu et al., 2018). In pure ALOHA, the time of transmission is continuous. Therefore, when a station has an available frame, that frame is immediately transmitted. In case of a collision wherein the frame is destroyed, the sender waits a random amount of time before retransmitting it. The slotted phase is the next ALOHA phase, and results from the induction of the pure ALOHA phase and its abstraction. This abstraction process enhance transmission process, which is directly proportional to length of transmission of data packet and the total frame occurrences. The drawback of this approach is that the message can be shared only once, initially, resulting in a decreased collision count.

RFID technology tracks objects in motion resulting in numerous opportunities for application. These RFID applications are in the health domain, hospitality, travel, government, retail, and productions, to name a few

3. RFID applications

Earlier literature discussed various applications of RFID, effective implementation strategies, and best practices (Delaunay et al., 2007; Chanchaichujit et al., 2020). Adoption barriers to RFID, its commercial applications, and the advantage of using RFID in supply chains was discussed by Hunt et al. (2007), Lim et al. (2013), Chongwatpol and Sharda (2013) and Abdullah et al. (2020). According to one estimate, RFID global markets will rise to $15.84 billion USD (Shree et al., 2020) by the third quarter of the financial year 2021-22. RFID contributes to more than $1.3 billion of revenue across the supply chains of both manufacturing and service industries. The cost of an individual tag, however, is still relatively high, which poses barriers for applications such as labeling goods. For widespread usage, RFID tag costs need to be a fraction of the margins on goods, especially in the retail sector. Cost appears to be the main hindrance to RFID implementation. For this reason, many researchers worked on an alternate, economical design (Abdullah et al., 2020; Adikari et al., 2021; Arjun et al., 2021). Table 2 depicts the literature summarizing RFID applications in various industries.

The in-depth literature review resulted in the following considerations for incorporating RFID in supply chains:

- The business ascertains and dictates the key requirements of optimizing supply chains, especially the manufacturing operations.
- Trading strategies and regulations set by business stakeholders provide the limiting parameters for the application of RFID to the supply chain.
- Modeling and studying the current “as is” operating conditions and corporate agreements is essential to understanding the issues and challenges in the existing supply chains.
- The supply chain optimization process is impacted by the type and quantity of inputs (raw materials) and outputs (products or objects) being manufactured and transported.

The literature study further revealed that RFID’s potential to optimize processes is maximized in a business that manufactures and transports more than 1000 objects. This parameter is based on the cost-benefit of RFID application due to scalability. Table 3 summarizes the benefits and challenges of using RFID to optimize supply chains.

RFID can be deployed in Point of Sales (PoS), warehouses, logistics, and distribution processes in order to improve their efficiency. During deployment, gateways in RFID readers keep critical decision points in mind. These critical points are identified in the supply process for the purpose of optimization (Abdullah et al., 2020). RFID implementation starts with studying the accuracy of inventory management and firm-level decisions related to inventory planning and procurement of material (Kar & Pani, 2014). A study by Lagorio et al. (2020) identifies the innovative approaches for stock inventory, procurement, and storage. Benčić et al. (2019) show that 70% of data recorded in the system contradicts the physical stock of over 350,000 units. The misplaced or lost stock reduces nearly 20% of the total profit. Unreliable inventory management impacts overall supply chain efficiencies and presents major challenges to efficiently running businesses. RFID technology improves inventory management by enabling precise data collection on raw materials from the supplier, storage in warehouses, and eventual distribution of finished products through supply chains. RFID-generated real-time data has the potential to reduce waste and improve quality as it can predict peaks and valleys in operations. RFID optimizes supply chain logistics by coordinating demand with supply, identifying bottlenecks in processes, and rapidly suggesting alternatives (Chanchaichujit et al., 2020). Fig. 2 explains the utilization of RFID in supply chain integration.

RFID tags can generate data from suppliers to from the manufacturing stage to sales, resulting in efficiencies and effectiveness for the entire organization. RFID technology also improves the goods distribution process (Camargo et al., 2020). From an operational perspective, attaching the RFID tag to all relevant materials and products starts the process of identification. Reading the tag, which may happen at the end of a conveyor belt, is the next step after creating identification. Data from the tag is transmitted to a database, typically on the cloud. The product then moves to the distribution center to be further classified and transferred to retailers. Tag readers at the distribution center identify and segregate the product to maximize distribution efficiency. Similar processes are repeated in retail stores to identify the incoming product and transfer the data back to the RFID enterprise database. With the help of readers, the movement and location of products are easily identified throughout the process. Fig. 1 summarizes RFID as an iterative and incremental technology that deploys radio frequency (RF) signals to identify and communicate with objects. Once the data is analyzed, it can be used to enhance various functional areas and systems such as demand fulfillment, forward and backward order management, as shown in Table 4.

RFID technology is based on the concept of radio- frequency that signals embedded static objects and objects in transit. This auto-identification includes access cards and electronic wallets. RFID data is widely used in tool tracking, process management, and access control.

3.1. Application of RFID in SCM optimization in the light of industry 4.0

Supply Chain Management (SCM) is undergoing a strong linkage between information, material, and fund flows with technologies and constantly progressing towards adoption of digital technologies (Núñez-Merino et al., 2020). Earlier, the commercial usage of SCM was limited to adoption of conventional radio frequency tags and sensors for intra-organizational performance. With the advancement of Industry 4.0 technologies, including cloud computing, smart sensors are gaining popularity in control systems and route activities, including inventory management and logistics (Ivanov et al., 2018). As a result, operational performance, productivity, and high visibility across multiple processes are enhanced. Particularly, technologies like RFID and IoT in supply chains provide economic benefits to the business. With the

Table 2
RFID applications in various industries.

Contributors	Level of Analysis	Tools	Context
Xiao et al. (2017), Huang et al. (2019), Chu et al. (2021)	Firm	Thematic Analysis	Commercial off-the-shelf (COTS) RFID-equipped robot for precision location in supply networks.
Benčić et al. (2019), Popović et al. (2021)	Firm	Cost Analysis	Technology enabled distributed ledger and IoT enabled supply Networks
Rodger (2017)	Healthcare Industry	Entropy Model	Markov blanket entropy approach that aim to minimize inventory cost, waste reduction and enhancing sustainability.
Ray et al. (2015)	Firm	Heuristic Techniques	Near-optimal allocation of monitor aims to minimize energy consumption.
Lu et al. (2017)	Transportation Industry	Dolph-Chebyshev Antenna Array	With low fluctuation and consistency in data fetching and execution, far-filed RFID systems are established.
Joshi (2016); Xiao et al. (2017); Huang et al. (2019), Chu et al. (2021)	Cross-Industrial	Experimental	The aim is to reduce the execution time of fetching and execution of image processing.
Toyoda et al. (2017), Kshetri (2022)	Product Design	Experimental	Cost performance analysis and deployment of blockchain-based decentralized application platform.
Cuthbertson and Piotrowicz (2011)	Cross-Industrial	Experimental	Algorithm designing and testing was done to know the RFID viability in cross-industrial supply chain.
Karuppuswami et al. (2018), Herrojo et al. (2019), Fathi et al. (2020)	Dairy Industry	Experimental	Sensitivity analysis to evaluate the quality and supply of material by suppliers
Sharma et al. (2021), Zhu et al. (2020)	Transportation & Vehicle Tracking	Theoretical Analysis and Experimental	A novel and effective close detection approach was used to enhance real time supply chain process.
Sidorov et al. (2019), Paul et al. (2022)	Cross-Industrial	Theoretical Analysis and Experimental	Gong, Needham, and Yahalom logic has been developed to understand and evaluate storage, computational, and communication costs.
Björk et al. (2011), Chen and Kaakkurivaara (2019)	Inventory Control and Object Tracking	Theoretical	Tree Hopping (TH) protocol was testing to know the effect of RFID for inventory positioning and tracking during its in-transit status.
Chen et al. (2017, 2013)	Warehousing Management	Experimental	E-ERMI framework was developed and simulations were conducted to evaluate its performance in various application areas including inventory management, supply chain management, and distribution and retailing.
Shafique et al. (2019); Svub et al. (2020)	Pharmaceutical Industry	Structured Modeling	Embedded technologies including big data, IoT leads to benefits to the decision-makers in the sector to enhance the performance of supply chains.
Joshi and Dwivedi (2020)	Pharmaceutical Transportation Management	Experimental	Traceability system in a delivery van of the drug distributor in the city of Bilbao.
Sidhu et al. (2020)	Switch Gears Firms	Conceptual Framework	conceptual design approach is used to develop the functional design of switchgear for inventory performance enhancement.
Joshi and Dwivedi (2020)	Healthcare Industry	Theoretical Analysis and Experimental	Monitoring and Tracking Patient (MTP) for effective record keeping system.
Nezhad et al. (2021)	Textile and Clothing Manufacturing	Theoretical Analysis and Experimental	Enhanced tracing capabilities of the firm. Warehousing efficiency periodically increases due to the appropriate use of RFID technology.
Oghazi et al. (2018)	Multiple Industries	Case Analysis and Experimental	Integration of RFID with Enterprise Information System helps supply chain to become more responsive and efficient.
Chanchaichujit et al. (2020); Corches et al. (2021)	Multiple Industries	Thematic Analysis	Enhanced industrial usage of RFID as a benefit-driver and sustainable competitive advantage.

Table 3
Benefits and Challenges of using RFID.

Benefits	Cost Reduction	Usage of RFID leads to positive ROI and High returns with waste reduction across the cost centres (Hijazin & Zhang, 2019; Sharma et al., 2022).
	Enhanced Product Quality and Safety	High visibility towards the material in transit (Sharma et al., 2020a; Koohang et al., 2022)
	Inventory Discrepancy Reduction	RFID technology provides two key advantages to the supply chain: first, the visibility allows precise inventory monitoring and replenishment, and second, reduction in causes of discrepancies (Ustundag & Tanyas, 2009), between inventory record and the actual inventory (Delaunay et al., 2007; Sarac et al., 2010). These RFID advantages result from improved visibility and control (Kumar et al., 2021).
Challenges	Standardization	The standardization benefits are lost if multinational organizations have to invest in different RFID technologies (Smith, 2021).
	Privacy and Legal issues	Simple and secure tags that ensure personal data privacy are required before consumers trust and retailers implement RFID on a mass scale (Ben-Daya et al., 2019).
	Other Barriers	Adoption issues and other contemporary issues (Abdullah et al., 2020; Lim et al., 2013).

technological extension and commercial usage of robotics and augmented reality, supply chains are getting further optimized (Chauhan & Singh, 2019). Industry 4.0 is paving the way for future factories that have smart warehousing and optimized logistics. Business benefits include advanced levels of agility, transparency, efficiency, and traceability in supply chain activities (Fernández-Caramés et al., 2019). Data automation is an essential base for deploying Industry 4.0 to supply chain activities. Without data, businesses struggle to optimize their operations and supply chains. Rafiquea et al. (2022) discuss the relevance of RFID and Industry 4.0 technologies in the context of a technology-organizational-environmental (TOE) framework. IoT is among the most suitable and easy to adopt digital technologies, making it easy to deploy to an existing supply chain. IoT creates a network of smart devices that creates an ecosystem of digital and physical objects. IoT lays the foundation for the allied technologies under Industry 4.0. Kamble et al. (2019) discussed the relevance of IoT in the retail sector.

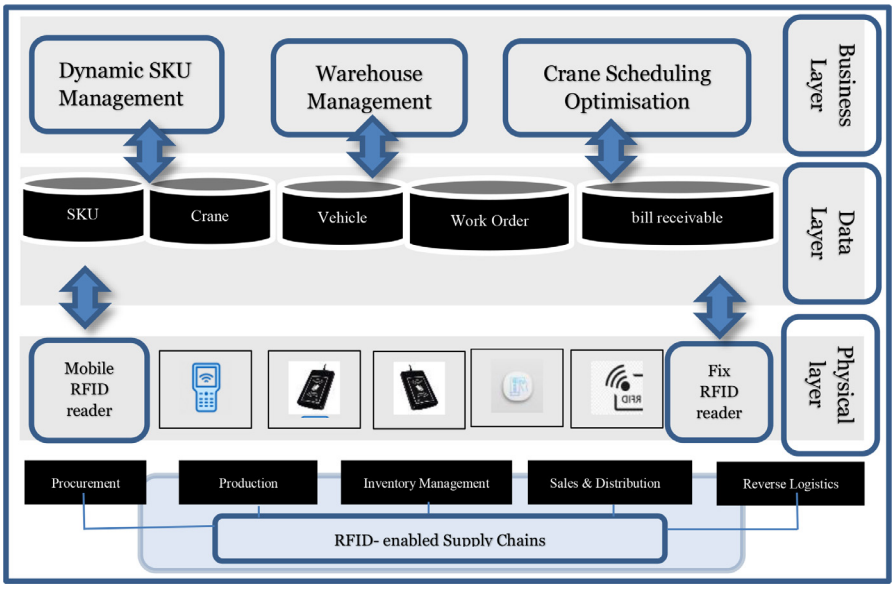

Fig. 2. Schematic representation of RFID-enabled supply chain optimization model (adapted from: Xu et al., 2013).

Table 4
Supply chain management process and RFID applications.

Supply Chain Management Processes	Description
Demand Management	RFID-generated data ameliorates inaccuracies due to human error. RFID can also generate sufficient volumes of data for analysis. Timely data for each item and in the aggregate enables analysis and generates insights. Predictive analytics on aggregate data matches demand with supply. Aggregate analytics-based planning is enhanced by sufficient and accurate RFID data that reduces costly buffer stocks while matching the demand (Kushwaha et al., 2021; Kato, 2021; Arjun et al., 2021; Adikari et al., 2021).
Order Fulfillment Management	RFID data facilitates process automation in materials handling, shelving, cross-docking, and retrieval.
Manufacturing Flow Management	RFID technology helps streamline assembly lines. Streamlined automation in the assembly line reduces throughput time. RFID-enabled automation and tracking also improves the visibility of products and their velocity in the supply chain (Arjun et al., 2021; Kapoor et al., 2021).
Returns Management	Customer returns add to the inventory pile. RFID technology provides downstream visibility of negative demands (Konstantakopoulos et al., 2021), thereby helping the organization understand its real inventory in real-time.

The research explored the benefits of IoT in improving product visibility, data extraction, and inter-supplier communication, and as a tool for business intelligence. Based on the previous literature, authors explored the benefits and challenges of RFID technology in SCM. In addition, the types of commercial and non-commercial available RFID are explored through two case studies. The practical benefits of the technology is discussed in Table 5.

Various types of commercial and non-commercial RFID are available in the market. Table 6 shows vendors who manufacture and sell RFID. Two specific scenarios are studied in order to understand and compare the benefits of RFID.

In the first scenario, a supply chain process is examined without the application of RFID. In the second scenario, the RFID technology is applied to that same supply chain process. Business enterprises needs a strategy to analyze applying the key benefits of RFID to improve the process by decreasing the delay of supplies. RFID technology can help by transmitting data in a timely and accurate manner which improves the overall efficiency of the process.

Efficiency in the supply chain process is achieved by embedding RFID as a service, in the networks, or as an IT infrastructure. RFID with remote data transmission helps decision-makers in supply chains. Fig. 3 depicts the operations process of the supply chain firm when RFID technology is implemented. With the emergence of advanced technologies, including cloud computing and robotics, RFID-based business applications are continuously evolving and rising (Xiao, 2021; - Sharma et al., 2021). Fig. 4 explains the organisational process with the usage of RFID. The licensed document is then processed to the central or key distribution center. The total time required with RFID-enabled processing is three days, compared to 45 days without the technology.

The introduction of a warehouse system that uses emerging technology for various supply chain activities is the second phase. The aim is to interconnect headquarters, the central distribution center, and the local centers. This system connects the repair shop to the local distribution center, which provides a smooth flow of products. In the final phase of the process, the start and endpoints of the supply chain are equipped with RFID readers to automate data collection and transmission. The tags to collect data are attached to the products at a pallet level. The data is transmitted to the warehouse system through an internal network. Compared to manual data collection, the RFID automates the data collection and transmission, thereby improving the process efficiency (Bianco et al., 2021; Koohang et al., 2022; Paul et al., 2022).

- Following are the tangible benefits of an RFID-based warehouse system:
- Efficiencies in storage led to a reduction in warehouses, from 35 to 23.
- Human errors decreased due to automation; inventory was collected by scanning barcodes.
- The integration of activities created continuity in the process, as compared with manual scanning.
- Data analysis is used to estimate the quantity of material required and identify expected delivery of material.
- All relevant points of the supply chain (HQ, key distribution center, and local centers) exchange and interpret the data for improved efficiency.

3.2. RFID in smart automation along supply chain information management

The growing use of digital technologies has raised new opportunities across businesses. For instance, retail firms use underneath technologies like RFID alongside digital technologies to design and develop agile

Table 5
Benefits of RFID application in business processes for supply chain management.

Business Function	Benefits
Customer Relationship Management (CRM)	Enhanced visibility into customer needs (Bu & Li, 2017; Chen, 2020; Raza, 2021; Arjun et al., 2021). Customer reordering pattern designing in a supermart (Zuo et al., 2018; Pür & Sağiroğlu, 2020). Third party logistics management (Yang & Dong, 2011; Adikari et al., 2021; Liukkonen, 2015).
Production Planning (PP) and Production Management (PM)	Operation cost reduction (Shafique et al., 2019; Nguyen et al., 2021; Yang et al., 2021). enhancement of labor productivity (Sidorov et al., 2019; Paul et al., 2022; Björk et al., 2011). Data acquisition cost reduction (-Shafique et al., 2019 Real time monitoring of production activities (Zeng & Wang, 2011). Optimize supply chain management applying active RFID technology (Nguyen et al., 2021; Yang et al., 2021) Improved Product Life cycle (Guo et al., 2019). RFID-based production and distribution management systems for the home appliance industry (Gonzalez et al., 2006; Aziz et al., 2021). An intelligent system for production resources planning (Liu, 2021) Optimizing supply chain waste management through the use of RFID technology (Reyes et al., 2020; Reyes et al., 2021). Accurate and timely asset tracking and smart product recycling (Shafique et al., 2019; Nguyen et al., 2021; Yang et al., 2021).
Material Management (MM)	Enhanced security toward material handling towards theft and possible damage due to mishandling (Hunt et al., 2007; Chongwatpol & Sharda, 2013). Enhanced visibility along the supply chain (Guo et al., 2019; Sharma et al., 2020a, 2020c). Material traceability enhancement (Tian, 2016; Syed et al., 2022; Zeng & Wang, 2011). Optimisation in inventory costs (Xie & Rui, 2010; Singh et al., 2017; Fanti et al., 2017).
Enterprise Resource Planning (ERP)	Information usage optimisation using RFID (Nair et al., 2021; Verma et al., 2021)
Financial Management (FM)	Improved technology return on investment - (Lee and Lee, 2010) The financial impact of using RFID in healthcare (Nair et al., 2021) Financing planning (Joshi and Dwivedi, 2020). Innovative financing scheme by RFID (Inaba, 2007). Capital structure design (Miragliotta et al., 2009).

Table 6
RFID products and areas.

Leading Firms	Areas of Expertise
Zebra	Among the leading manufacturers of RFID tags and readers. Reader types include Fixed, Handheld, and Hands-free. Provides customized solutions to clients by providing its own RFID tag printing facility (Forcinio, 2007; Trebilcock, 2005).
Alien Technology	Ranked among the few renowned suppliers of RFID technology. Has a huge portfolio dealing in RFID tags, labels, readers, and antennas. Also known for 'Alien Academy,' its hardware and networking training institute chain. (Choudhary et al., 2017, 2018; Gupta, 2021)
Checkpoint Systems	An expert in retail RFID solutions. Deals in corporate solutions for stock theft prevention, stock tracking, and mapping (Camargo et al., 2020; Casamayor-Pujol et al., 2021)
Nedap	An expert in RFID solutions for retail warehousing. Develops solutions for mega marts, supermarkets, electronics, and consumable retailers (Munoz-Ausecha et al., 2021).
Tyco Retail Solutions	Has an 80% share of the total market across retails solutions, with expertise in anti-theft solutions (Camargo et al., 2020; López et al., 2021; Choi, 2017).
Smartrac	An expert solution provider of RFID particularly for e-passports. Also provides retail store optimization and IoT solutions (Camargo et al., 2020; López et al., 2021).
Alliance Tech	Offers intelligent RFID solutions for office, conferences, and events including daily staff attendance and registration of devices (Oztemel & Gursev, 2020).

supply chains and omni-channels (Oliveira-Dias et al., 2022). Whereas retail logistics firms are using IoT devices along RFID and big data analytics for route operations including route design and delivery performance (Alberti-Alhtaybat et al., 2019). Factories of the future and their supply chains shall compete on data management technology being a source. Such setups are the learning factory using a low-cost RFID tracking system and embedding IoT for enterprise-wide information exchange and management (Oztemel & Gursev, 2020). Their success is largely dependent on agile structures, highly responsive "cognitive systems" (Brecher & Weck, 2022). The information systems within a cognitive system includes cyber-physical control systems, RFID and IoT devices, and security systems (John et al., 2021). Thus, designing and implementing a sustainable information system is based on multisensory information fusion (Liu, 2021). Applications for cognitive systems include human-machine interfaces, smart automation, logistics management, healthcare, tourism supply chains and agri-food supply chain management (Dutta et al., 2021). Table 7 discusses the RFID application in the supply chain activities. The information management in the modern supply chains are based on multiple digital technologies including cloud computing, big data analytics, cyber-physical systems at place that manage the cognitive systems at various levels including computational modeling, algorithm and system integration (John et al., 2021). Thus, the socio-cyber-physical work systems are using Industry 4.0 to develop a sustainable cognitive system that covers all stakeholders across the supply chain (Hozdić & Butala, 2020).

RFID implementation in the supply chain faces two major challenges: adoption issues in supply chain processes and the cost of tags. Effective strategies in handling these challenges include precise and extensive modeling of supply chain processes and mass producing RFID tags. Process modeling enhances the flow in the supply chain. RFID costs need to be compared with the corresponding positive impacts on business, which result in increased capital flow and reduced inventory waste. RFID implementations require a cost-benefit analysis.

Time and cost savings together with the reduction in waste provide significant justification for RFID implementation. Following are some key statistical data that justify the use of RFID. The time consumed and the retrieval report of central distribution centers (CDC) and local distribution centers (LDC) before and after implementation of RFID, are shown in Table 8. Finally, Table 9 exhibits overall the optimization time and includes inward & outward time, shipment time, and overall time for both scenarios discussed earlier.

4. Discussion

The research follows a systematic literature review approach to explore the academic research on RFID and decision support systems in light of Industry 4.0. This study identifies the significance of RFID in enhancing operations and supply chain management activities. The review covered various themes, including organizational strategies towards adopting new technologies, including RFID, sustainable

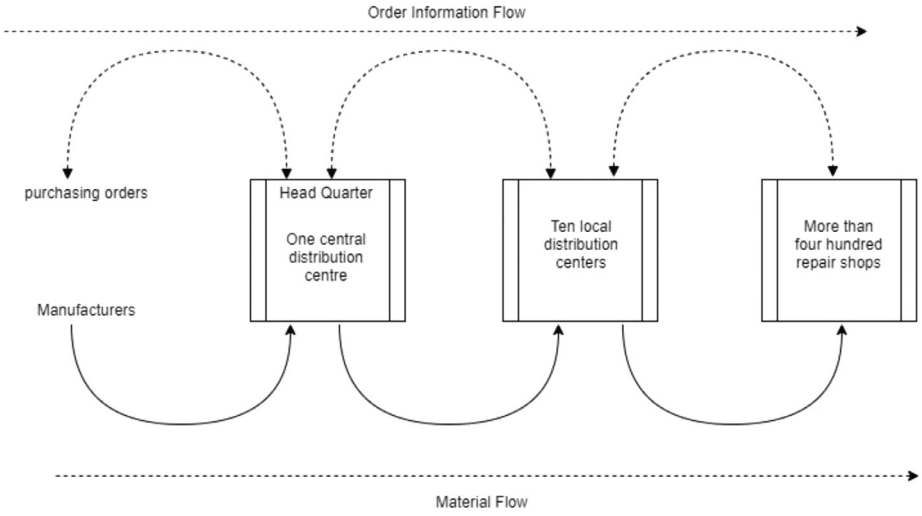

Fig. 3. Layout without RFID.

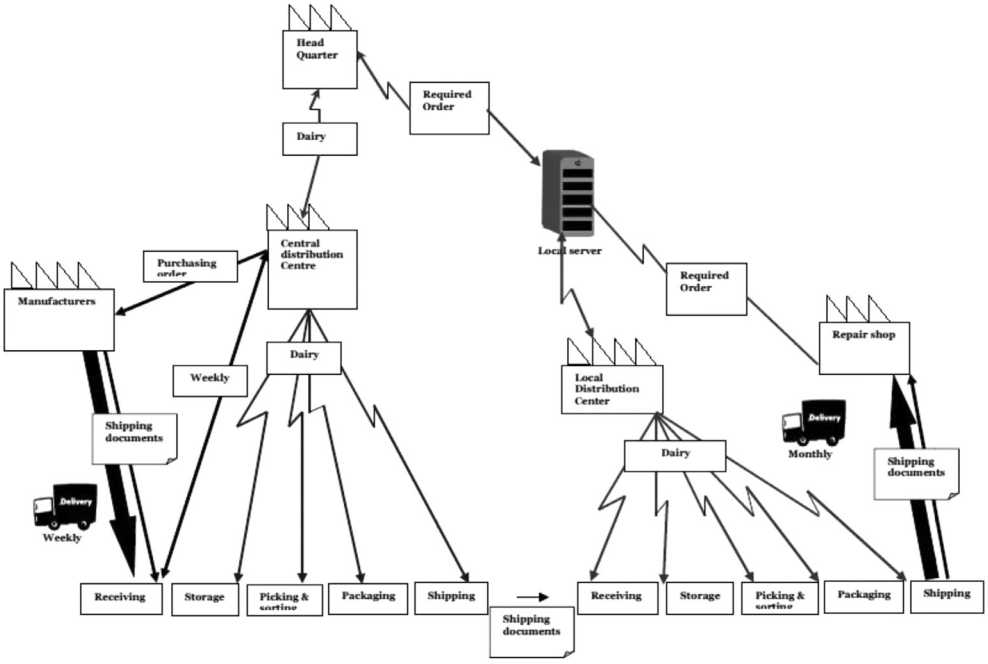

Fig. 4. Layout with RFID.

Table 7
RFID applications in supply chain activities.

Application	Description
Shipping and Container Business	The RFID technology enables the efficiency of the process of receiving orders, processing of orders, stock movement and its management, and close monitoring of stock out situations in the shipping and container business (Hunt et al., 2007). Real-Time Location System (RTLS) improves operations in container terminals (Savino et al., 2018; Shafique et al., 2019). New advancements like container management systems based on RFID technology - Lee and Lee, 2010; Li et al., 2016) can enhance the container location and movement tracking.
Retail Industry	Stock tracking is a major challenge in the retail industry. RFID tags constantly gather the position of the stock (from distribution center to retail outlet and point of sales onwards (Kamble et al., 2019; Sharma et al., 2020a; Joshi & Sharma, 2021). Network analysis techniques for buying behavior in the supermarket to gauge the demand is reported by Zuo et al. (2018), Sharma et al. (2020c) and Verma et al. (2021).
Manufacturing sector	The manufacturing domain has developed a variety of RFID-based systems together with cloud computing. These RFID-based systems generate and utilize real-time data for various production activities. These systems also improve production scheduling using RFID through emerging technologies (Yan et al., 2020).
Agriculture and Food Processing	In agriculture and farming, RFID identifies and tracks livestock and food chain. RFID is also deployed in food items storage and in pre-harvesting agriculture activities including weather monitoring, water supply for irrigation purposes, crop selection, and farm machinery (Liang et al., 2021).
Healthcare	RFID applications for healthcare include accurate health records, asset tracking (example. Public blood banks), patient identification, and tracking in-patient movements (Abdullah et al., 2020; Adikari, et al., 2021).
Pharmaceutical	The pharmaceutical sector utilizes RFID technology for the security of goods and identification of counterfeit products (Rodger, 2017; Smith, 2021).

Table 8
Time before RFID implementation.

Distribution Center	Item (per order)	Unit	Pre- Implementation	Post-Implementation	Improvement (%)
CDC	Average Time: Between Outward and Inward	Min	88.9	16.2	81.77
	Average Time: Transaction	Sec	10.0	1.0	90
	Average Time: Transaction Retrieval	Sec	10.3	1.0	90.29
LDC	Average Time Between outward and inward	Min	43.6	13.0	70.18
	Average time: Transaction	Sec	10.4	1.0	90.38
	Average Time: Transaction Retrieval	Sec	10.0	1.0	90

Table 9
Overall optimization time.

Item	Time	Without RFID	With RFID	Improvement Percentage (%)
CDC	Inward-Outward Duration	1200.0	146.0	87.83
	Shipment time	5.5	1.9	65.45
	Overall time	1205.5	147.9	87.73
LDC	Inward-Outward Duration	120.0	98.0	18.33
	Shipment Time	3.1	1.3	58.06
	Overall Time	123.1	99.3	19.33
Supply Chain	Inward-Outward Duration	1320.0	244.0	81.51
	Shipment Time	8.6	1.2	86.04
	Overall Time	1328.6	245.2	81.54

development, modern techniques, information system approaches towards supply chain designing and their management, and benefits of RFID and Industry 4.0. From the industrial strategy perspective, the RFID adoption can be observed as the cost drivers towards optimizing the supply chain function through digitalization (Sarkar & Shankar, 2021). The convergence of Industry 4.0 technologies with RFID has the potential to add value for businesses through operational excellence. RFID technology implementation in the supply chain needs to address business functions, technology infrastructure, and industrial strategies (Guo et al., 2019; Kamble et al., 2019; Pandey et al., 2021). Key benefits of using RFID-enabled robots includes cost reduction, stock tracking, response time reduction, and improvements in overall operations of a business in the logistics and supply chain industry (Casamayor-Pujol et al., 2021). This paper illustrates the role of RFID in various aspects of supply chains. The review also explores potential inefficiencies in the operations and management of inventory techniques (Ustundag & Tanyas, 2009; Zhang & Wang, 2018; Reyes et al., 2021), and proposes RFID as a means to optimize business processes. Two scenarios are developed and compared using statistics, which illustrates the advantages of RFID in the business process. For example, RFID, reduces errors from manual processes. The overall logistic costs and losses due to misplaced materials and products are reduced. When errors are reduced in the supply chain process, the total revenue is increased by 20% (Abdullah et al., 2020).

The results indicate potential savings of up to 84% of the total transportation time and lag time (Newman-Casey et al., 2020). The other advantage is the nearly 60% reduction in time to provide materials that improve the total efficiency of a supply chain by nearly 80% (Bianco et al., 2021; Paul et al., 2022). RFID established as a global technology that gives industrial advantages and shows significant adoption across industries including healthcare supply chains (Cui et al., 2022; Mohanty et al., 2022), transportation management and location tracking, (Subbulakshmi et al., 2022; Umapathi, et al., 2022), aerospace and defense operations (Goritiyal, et al., 2022), urban planning (Sharma et al., 2020a; Yang et al., 2021), retail operations (Kamble et al., 2019; Bellini et al., 2022), tourism supply chain management (Bose et al., 2022), smart manufacturing (Rafiquea et al., 2022; Sharma et al., 2021). The variety of applications of RFID-enabled technologies reveals its significance in improving traceability in supply chains and overall effectiveness in business (Syed et al., 2022), primarily in areas like agriculture and food supply chains (Mai et al., 2010; Liu, 2022; Ramasubramaniam & Karthiayani, 2022). Despite its advantages, the RFID-based application in supply chain management often comes across many challenges, like retail management tag-collisions, customer privacy, and issues related to data integration. In logistics challenges broadly include security across multi-RFID tags. In operations and production challenges including data management and in compatibility among IS of suppliers and focal firm. The emergence of Industry 4.0 in supply chain activities required functional data decisions and solutions in areas including procurement, production operations, warehousing, logistics, and distribution (Camargo et al., 2020). The integration of RFID and the Internet of Things (known as RFID-IoT) has brought advancement through smart operations using automated sensing and pervasive computing, so that ubiquitous data is available to all supply chain parties including producers, distributors, and consumers. The data available enhances process efficiency and tracking, and improves service experience to the customers -. The role of RFID-IoT in maximizing supply chain efficiency and cost effectiveness supports the data analysis and formulation of the decision support system to support digital transition to smart factories (Teixeira et al., 2022), warehouse management (Lim et al., 2013; Xu et al., 2013); cargo transportation, (Baygin et al., 2022) and other societal applications including mobility (Auer et al, 2022; Sharmila et al., 2022), attendance systems (Kariapper, 2021); food production and distribution (Lao et al., 2010), and physical retailing (Pantano & Willems, 2022). In order to cater to the above listed challenges, we have proposed an RFID-IoT-enabled Decision Support System.

Fig. 5 presents a conceptual framework for an RFID-IoT enabled Decision Support System**.** The framework is primarily based on the absorption capability of an organization using RFID in an Industry 4.0 context. Based on the comprehensive review, the authors propose a conceptual framework for an RFID-IoT enabled decision support system. The framework can be utilized as the roadmap for empirical and qualitative research in the near future. The practical implications of the study can be understood through developing multiple industrial cases.

5. Conclusions, limitations and future research directions

This study inspected sources that were published in journals and indexed in Scopus databases between 2000 and 2021, which provided important articles on RFID technology and decision support systems in the light of Industry 4.0. Further studies should be oriented to how various allied technologies, including IoT and AI, can assist supply chain performance. The review covered various themes, including organizational strategies towards adopting new technologies, including RFID, sustainable development, modern techniques, information system approaches towards supply chain designing and their management, and benefits of RFID and Industry 4.0. The results indicate potential savings of up to 84% of the total transportation time and lag time, nearly 60% reduction in time to provide materials that improve the total efficiency of a supply chain by nearly 80%. RFID technology is established as a global technology that gives industrial advantages and shows significant adoption across industries including healthcare supply chains. This study has offered suggestions on operational efficiency of supply chains while reducing the costs of implementing the RFID technology. The core contribution of this paper is its analysis and evaluation of various RFID

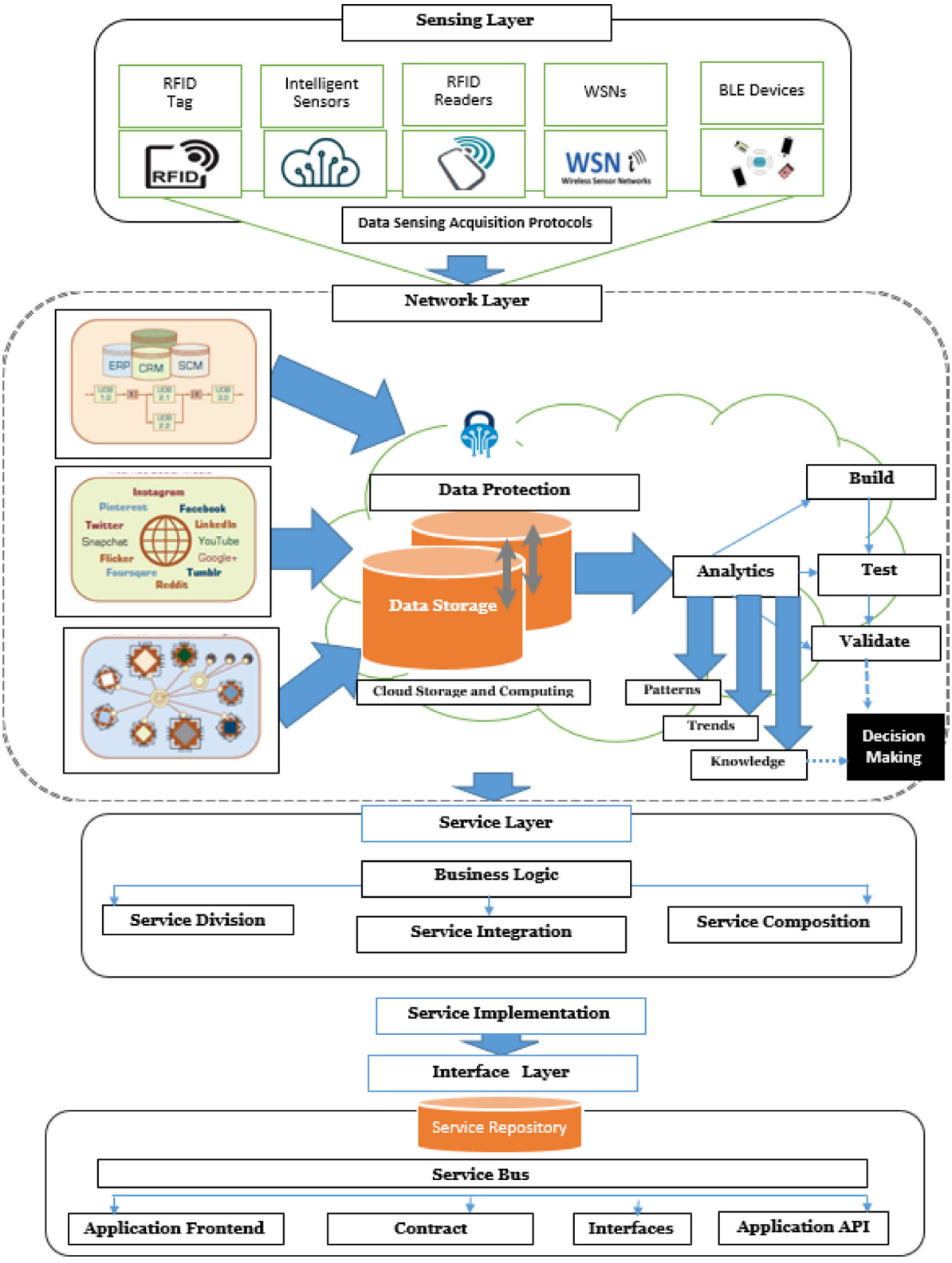

Fig. 5. Proposed conceptual framework for a RFID-IoT-enabled decision support system.

implementation methods in supply chains with the aim of saving time effectively and achieving cost efficiencies. The scope of this research is limited to studying RFID's impact on supply chains. Future research should investigate the relationship between RFID-IoT with the physical internet and examine how real-time data processing can continue to optimize decision making in supply chains.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abdullah, A., Stroulia, E., & Nawaz, F. (2020). Efficiency optimization in supply chains using RFID technology. *In 2020 IEEE Intl conf on dependable, autonomic and secure computing, intl conf on pervasive intelligence and computing, intl conf on cloud and big data computing, intl conf on cyber science and technology congress (DASC/PiCom/CBDCom/CyberSciTech)* (pp. 1–6). IEEE. 10.1109/DASC-PICom-CBDCom-CyberSciTech49142.2020.00017.

Abramson, N. (1970). *The ALOHA system annual report, 1969*. Defense Technical Information Center.

Adikari, A., Burnett, D., Sedera, D., de Silva, D., & Alahakoon, D. (2021). Value co-creation for open innovation: An evidence-based study of the data-driven paradigm of social media using machine learning. *International Journal of Information Management Data Insights, 1*(2). 10.1016/j.jjimei.2021.100022.

Alberti-Alhtaybat, L. V., Al-Htaybat, K., & Hutaibat, K. (2019). A knowledge management and sharing business model for dealing with disruption: The case of Aramex. *Journal of Business Research, 94*, 400–407. 10.1016/j.jbusres.2017.11.037.

Arjun, R., Kuanr, A., & Suprabha, K. R. (2021). Developing banking intelligence in emerging markets: Systematic review and agenda. *International Journal of Information Management Data Insights, 1*(2), Article 100026. 10.1016/j.jjimei.2021.100026.

Auer, S., Nagler, S., Mazumdar, S., & Mukkamala, R. R. (2022). Towards blockchain-IoT based shared mobility: Car-sharing and leasing as a case study. *Journal of Network and Computer Applications*, Article 103316. 10.1016/j.jnca.2021.103316.

Aziz, O., Anees, T., & Mehmood, E. (2021). An efficient data access approach with queue and stack in optimized hybrid join. *IEEE Access, 9*, 41261–41274. 10.1109/ACCESS.2021.3064202.

Badia-Melis, R., Mc Carthy, U., Ruiz-Garcia, L., Garcia-Hierro, J., & Robla Villalba, J. I. (2018). New trends in cold chain monitoring applications: A review. *Food Control, 86*, 170–182. 10.1016/j.foodcont.2017.11.022.

Batta, A., Gandhi, M., Kar, A. K., Loganayagam, N., & Ilavarasan, V. (2020). Diffusion of blockchain in logistics and transportation industry: An analysis through the synthesis of academic and trade literature. *Journal of Science and Technology Policy Management, 12*(3), 378–398.

Baygin, M., Yaman, O., Baygin, N., & Karakose, M. (2022). A blockchain-based approach to smart cargo transportation using UHF RFID. *Expert Systems with Applications, 188*, Article 116030. 10.1016/j.eswa.2021.116030.

Bellini, P., Palesi, L. A. I., Nesi, P., & Pantaleo, G. (2022). Multi clustering recommendation system for fashion retail. *Multimedia Tools and Applications*, 1–28. 10.1007/s11042-021-11837-5.

Benčić, F. M., Skočir, P., & Žarko, I. P. (2019). DL-Tags: DLT and smart tags for decentralized, privacy-preserving, and verifiable supply chain management. *IEEE Access, 7*, 46198–46209. 10.1016/j.eswa.2013.07.006.

Ben-Daya, M., Hassini, E., & Bahroun, Z. (2019). Internet of Things and supply chain management: A literature review. *International Journal of Production Research, 57*(15-16), 4719–4742. 10.1080/00207543.2017.1402140.

Bianco, G. M., Occhiuzzi, C., Panunzio, N., & Marrocco, G. (2021). A survey on radio frequency identification as a scalable technology to face pandemics. *IEEE Journal of Radio Frequency Identification, 6*, 77–96. 10.1109/JRFID.2021.3117764.

Björk, A., Erlandsson, M., Häkli, J., Jaakkola, K., Nilsson, Å., Nummila, K., & Sirkka, A. (2011). Monitoring environmental performance of the forestry supply chain using RFID. *Computers in Industry, 62*(8-9), 830–841. 10.1016/j.compind.2011.08.001.

Bose, D., Mohan, K., CS, M., Yadav, M., & Saini, D. K. (2022). Review of autonomous campus and tour guiding robots with navigation techniques. *Australian Journal of Mechanical Engineering*, 1–11. 10.1080/14484846.2021.2023266.

Brecher, C., & Weck, M. (2022). *Production control technology. Machine tools production systems 3. Lecture notes in production engineering*. Wiesbaden: Springer. 10.1007/978-3-658-34622-5_14.

Bu, K., & Li, Y. (2017). Every step you take, I'll be watching you: Practical StepAuth-anticipation of RFID paths. *IEEE Transactions on Information Forensics and Security, 13*(4), 834–849.

Camargo, L. R., Pereira, S. C. F., & Scarpin, M. R. S. (2020). Fast and ultra-fast fashion supply chain management: An exploratory research. *International Journal of Retail and Distribution Management, 48*(6), 537–553. 10.1108/IJRDM-04-2019-0133.

Casamayor-Pujol, V., Gastón, B., López-Soriano, S., Alajami, A. A., & Pous, R. (2021). A simple solution to locate groups of items in large retail stores using an RFID robot. *IEEE Transactions on Industrial Informatics, 18*(2), 767–775. 10.1109/TII.2021.3080670.

Chanchaichujit, J., Balasubramanian, S., & Charmaine, N. S. M. (2020). A systematic literature review on the benefit-drivers of RFID implementation in supply chains and its impact on organizational competitive advantage. *Cogent Business & Management, 7*(1), Article 1818408. 10.1080/23311975.2020.1818408.

Chauhan, C., & Singh, A. (2019). A review of industry 4.0 in supply chain management studies. *Journal of Manufacturing Technology Management*. 10.1108/JMTM-04-2018-0105.

Chen, H., Xue, G., & Wang, Z. (2017). Efficient and reliable missing tag identification for large-scale RFID systems with unknown tags. *IEEE Internet of Things Journal, 4*(3), 736–748. 10.1109/JIOT.2017.2664810.

Chen, J. C., Cheng, C.-H., & Huang, P. B. (2013). Supply chain management with lean production and RFID application: A case study. *Expert Systems with Applications, 40*(9), 3389–3397. 10.1016/j.eswa.2012.12.047.

Chen, T., & Kaakkurivaara, N. (2019). Comparison of radio frequency identification tag housings in a tropical forestry work environment. *Australian Forestry, 82*(4), 181–188. 10.1080/00049158.2019.1678797.

Chen, Y. (2020). A survey on industrial information integration, 2016–2019. *Journal of Industrial Integration and Management, 5*(01), 33–163. 10.1142/S2424862219500167.

Choi, T.-M. (2017). Pricing and branding for remanufactured fashion products. *Journal of Cleaner Production, 165*, 1385–1394. 10.1016/j.jclepro.2017.07.163.

Choi, T.-M., Yeung, W.-K., Cheng, T. C. E., & Yue, X. (2017). Optimal scheduling, coordination, and the value of RFID technology in garment manufacturing supply chains. *IEEE Transactions on Engineering Management, 65*(1), 72–84. 10.1109/TEM.2017.2739799.

Chongwatpol, J., & Sharda, R. (2013). RFID-enabled track and traceability in job-shop scheduling environment. *European Journal of Operational Research, 227*(3), 453–463. 10.1016/j.ejor.2013.01.009.

Choudhary, A., Gopal, K., Sood, D., & Tripathi, C. C. (2017). Development of compact inductive coupled meander line RFID tag for near-field applications. *International Journal of Microwave and Wireless Technologies, 9*(4), 757–764. 10.1017/S1759078716000751.

Choudhary, A., Sood, D., & Tripathi, C. C. (2018). Wideband long range, radiation efficient compact UHF RFID tag. *IEEE Antennas and Wireless Propagation Letters, 17*(10), 1755–1759. 10.1109/LAWP.2018.2844249.

Chu, C., Niu, J., Zheng, W., Su, J., & Wen, G. (2021). A time-efficient protocol for unknown tag identification in large-scale RFID systems. *IEEE Internet of Things Journal*. 10.1109/JIOT.2021.3139390.

Corches, C., Daraban, M., & Miclea, L. (2021). Availability of an RFID object-identification system in IoT environments. *Sensors, 21*(18), 6220. 10.3390/s21186220.

Cui, Y., Jung, E. M., Adeyeye, A., Lynch, C., He, X., & Tentzeris, M. (2022). Additively manufactured RF devices for 5G, IoT, RFID, WSN, and smart city applications. In *Nanotechnology for electronics, biosensors, additive manufacturing and emerging systems applications* (pp. 163–174).

Cuthbertson, R., & Piotrowicz, W. (2011). Performance measurement systems in supply chains: A framework for contextual analysis. *International Journal of Productivity and Performance Management, 60*(6), 583–602. 10.1108/17410401111150760.

Deepu, T. S., & Ravi, V. (2021). Supply chain digitalization: An integrated MCDM approach for inter-organizational information systems selection in an electronic supply chain. *International Journal of Information Management Data Insights, 1*(2), Article 100038. 10.1016/j.jjimei.2021.100038.

Delaunay, C., Sahin, E., & Dallery, Y. (2007). A literature review on investigations dealing with inventory management with data inaccuracies. *2007 1st Annual RFID Eurasia*. IEEE. 10.1109/RFIDEURASIA.2007.4368090.

Delen, D., Hardgrave, B. C., & Sharda, R. (2007). RFID for better supply-chain management through enhanced information visibility. *Production and Operations Management, 16*(5), 613–624. 10.1111/j.1937-5956.2007.tb00284.x.

Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: An overview. *International Journal of Logistics Research and Applications, 24*(4), 323–345. 10.1080/13675567.2020.1757053.

Dutta, R., Chowdhury, S., & Singh, K. K. (2021). *Managing IoT and cloud-Based healthcare record system using unique identification number to promote integrated healthcare delivery system: A perspective from India. Emergence of Cyber Physical System and IoT in Smart Automation and Robotics 119-134*. Cham: Springer.

Eksiouglu, (2014). RFID Adoption and Productivity Growth in US Retail Supply Chains.

Fanti, M. P., Iacobellis, G., Nolich, M., Rusich, A., & Ukovich, W. (2017). A decision support system for cooperative logistics. *IEEE Transactions on Automation Science and Engineering, 14*(2), 732–744. 10.1109/TASE.2017.2649103.

Fathi, P., Karmakar, N. C., Bhattacharya, M., & Bhattacharya, S. (2020). Potential chipless RFID sensors for food packaging applications: A review. *IEEE Sensors Journal, 20*(17), 9618–9636. 10.1109/JSEN.2020.2991751.

Fernández-Caramés, T. M., Blanco-Novoa, O., Froiz-Míguez, I., & Fraga-Lamas, P. (2019). Towards an autonomous industry 4.0 warehouse: A UAV and blockchain-based system for inventory and traceability applications in big data-driven supply chain management. *Sensors, 19*(10), 2394. 10.3390/s19102394.

Forcinio, H. (2007). Cashing in on the promise of RFID. *Managing Automation, 22*(5), 46–47.

Gonzalez, H., Han, J., Li, X., & Klabjan, D. (2006). Warehousing and analyzing massive RFID data sets. In 22nd International conference on data engineering *(ICDE'06)* (p. 83). 10.1109/ICDE.2006.171.

Goritiyal, C., Bairolu, A., & Goritiyal, L. (2022). Application of emerging technologies in aviation MRO sector to optimize cost utilization: The Indian Case. In *Intelligent sustainable systems* (pp. 161–176). Singapore: Springer. 10.1007/978-981-16-6369-7_15.

Guo, X., Yang, Z., & Tan, C. D. (2019). Emerging information technologies usage: opportunities and challenges for supply chain vulnerability. In *2019 IEEE international conference on industrial engineering and engineering management (IEEM)* (pp. 845–849). 10.1109/IEEM44572.2019.8978928.

Gupta, S. (2021). Deep learning based human activity recognition (HAR) using wearable sensor data. *International Journal of Information Management Data Insights, 1*(2), Article 100046. 10.1016/j.jjimei.2021.100046.

Herrojo, C., Moras, M., Paredes, F., Nunez, A., Mata-Contreras, J., Ramon, E., & Martin, F. (2019). Time-domain-signature chipless RFID tags: Near-field chipless RFID systems with high data capacity. *IEEE Microwave Magazine, 20*(12), 87–101. 10.1109/MMM.2019.2941634.

Hijazin, K., & Zhang, T. (2019). The application of IoT technology to a manufacturing process: Case study. In *2019 International conference on quality, reliability, risk, maintenance, and safety engineering (QR2MSE)* (pp. 203–210). IEEE. 10.1109/QR2MSE46217.2019.9021241.

Hozdić, E., & Butala, P. (2020). Concept of socio-cyber-physical work systems for industry 4.0. *Tehnicki Vjesnik, 27*(2), 399–410. 10.17559/TV-20170803142215.

Huang, J., Wen, Z., Kong, L., Ge, L., Wu, M. Y., & Chen, G. (2019). Accelerate the classification statistics in RFID systems. *Theoretical Computer Science, 788*, 39–52. 10.1016/j.tcs.2018.11.031.

Hunt, V. D., Puglia, A., & Puglia, M. (2007). *RFID: a Guide to Radio Frequency Identification*. John Wiley & Sons.

Inaba, T. (2007). Impact analysis of RFID on financial supply chain management. In *2007 IEEE international conference on service operations and logistics, and informatics* (pp. 1–6). 10.1109/SOLI.2007.4383927.

Ivanov, D., Sethi, S., Dolgui, A., & Sokolov, B. (2018). A survey on control theory applications to operational systems, supply chain management, and industry 4.0. *Annual Reviews in Control, 46*, 134–147. 10.1016/j.arcontrol.2018.10.014.

John, A., Mohan, S., & Vianny, D. M. M. (2021). Cognitive cyber-physical system applications. In *Cognitive engineering for next generation computing: A practical analytical approach* (pp. 167–187).

Joshi, S. (2016). Web 2.0 and its implications on globally competitive business model. In *Mobile computing and wireless networks: Concepts, methodologies, tools, and applications* (pp. 1638–1654). IGI Global.

Joshi, S., & Dwivedi, A. (2020). RFID SYSTEM-used for monitoring and tracking patient (MTP. In 2020 International conference on computer science, engineering and applications *(ICCSEA)* (pp. 1–10). 10.1109/ICCSEA49143.2020.9132938.

Joshi, S., & Sharma, M. (2021). Digital technologies (DT) adoption in agri-food supply chains amidst COVID19: An approach towards food security concerns in developing countries. *Journal of Global Operations and Strategic Sourcing*. 10.1108/JGOSS-02-2021-0014.

Kamble, S. S., Gunasekaran, A., Parekh, H., & Joshi, S. (2019). Modeling the internet of things adoption barriers in food retail supply chains. *Journal of Retailing and Consumer Services, 48*, 154–168. 10.1016/j.jretconser.2019.02.020.

Kapoor, N., Ahmad, N., Nayak, S. K., Singh, S. P., Ilavarasan, P. V., & Ramamoorthy, P. (2021). Identifying infrastructural gap areas for smart and sustainable tribal village development: A data science approach from India. *International Journal of Information Management Data Insights, 1*(2), Article 100041. 10.1016/j.jjimei.2021.100041.

Kar, A. K., & Pani, A. K. (2014). How can a group of procurement experts select suppliers? An approach for group decision support. *Journal of Enterprise Information Management, 27*(4), 337–357.

Kariapper, R. K. A. R. (2021). Attendance system using RFID IoT and machine learning: A two factor verification approach. *Systematic Reviews in Pharmacy, 12*(3), 314–321.

Karuppuswami, S., Matta, L. L., Alocilja, E. C., & Chahal, P. (2018). A wireless RFID compatible sensor tag using gold nanoparticle markers for pathogen detection in the liquid food supply chain. *IEEE Sensors Letters, 2*(2), 1–4. 10.1109/LSENS.2018.2822305.

Kato, T. (2021). Functional value vs emotional value: A comparative study of the values that contribute to a preference for a corporate brand. *International Journal of Information Management Data Insights, 1*(2), Article 100024. 10.1016/j.jjimei.2021.100024.

Konstantakopoulos, G. D., Gayialis, S. P., Kechagias, E. P., Papadopoulos, G. A., & Tatsiopoulos, I. P. (2021). An algorithmic approach for sustainable and collaborative logistics: A case study in Greece. *International Journal of Information Management Data Insights, 1*(1), Article 100010. 10.1016/j.jjimei.2021.100010.

Koohang, A., Sargent, C. S., Nord, J. H., & Paliszkiewicz, J. (2022). Internet of Things (IoT): From awareness to continued use. *International Journal of Information Management, 62*, Article 102442. 10.1016/j.ijinfomgt.2021.102442.

Kshetri, N. (2022). Blockchain systems and ethical sourcing in the mineral and metal industry: A multiple case study. *The International Journal of Logistics Management*. 10.1108/IJLM-02-2021-0108.

Kumar, S., Kar, A. K., & Ilavarasan, P. V. (2021). Applications of text mining in services management: A systematic literature review. *International Journal of Information Management Data Insights, 1*(1), Article 100008.

Kushwaha, A. K., Kar, A. K., & Dwivedi, Y. K. (2021). Applications of big data in emerging management disciplines: A literature review using text mining. *International Journal of Information Management Data Insights, 1*(2), Article 100017. 10.1016/j.jjimei.2021.100017.

Lagorio, A., Zenezini, G., Mangano, G., & Pinto, R. (2020). A systematic literature review of innovative technologies adopted in logistics management. *International Journal of Logistics Research and Applications*, 1–24. 10.1080/13675567.2020.1850661.

Lee, I., & Lee, B. C. (2010). An investment evaluation of supply chain RFID technologies: A normative modeling approach. *International Journal of Production Economics, 125*(2), 313–323. 10.1016/j.ijpe.2010.02.006.

Li, D.-Y., Xie, S.-D., Chen, R.-J., & Tan, H.-Z. (2016). Design of Internet of Things system for library materials management using UHF RFID. In *2016 IEEE international conference on RFID technology and applications (RFID-TA)* (pp. 44–48). 10.1109/RFID-TA.2016.7750755.

Liang, W., Xie, S., Zhang, D., Li, X., & Li, K. C. (2021). A mutual security authentication method for RFID-PUF circuit based on deep learning. *ACM Transactions on Internet Technology (TOIT), 22*(2), 1–20. 10.1145/3426968.

Lim, M. K., Bahr, W., & Leung, S. C. (2013). RFID in the warehouse: A literature analysis (1995–2010) of its applications, benefits, challenges, and future trends. *International Journal of Production Economics, 145*(1), 409–430. 10.1016/j.ijpe.2013.05.006.

Liu, H. (2022). Combating unethical producer behavior: The value of traceability in produce supply chains. *International Journal of Production Economics, 244*, Article 108374. 10.1016/j.ijpe.2021.108374.

Liu, S. (2021). Design and implementation of high-skilled talent information management system based on multisensor information fusion. Journal of Sensors, 2021. 10.1155/2021/3812145.

Liu, X., Yang, Q., Luo, J., Ding, B., & Zhang, S. (2018). An energy-aware offloading framework for edge-augmented mobile RFID systems. *IEEE Internet of Things Journal, 6*(3), 3994–4004. 10.1109/JIOT.2018.2881295.

Liukkonen, M. (2015). RFID technology in manufacturing and supply chain. *International Journal of Computer Integrated Manufacturing, 28*(8), 861–880. 10.1080/0951192X.2014.941406.

López, T., Riedler, T., Köhnen, H., & Fütterer, M. (2021). Digital value chain restructuring and labour process transformations in the fast-fashion sector: Evidence from the value chains of Zara & H&M. *Global Networks*. 10.1111/glob.12353.

Lu, S., Jiang, H., Liu, Y., & Huang, S. (2017). Regional disparities and influencing factors of average CO^2 emissions from transportation industry in Yangtze River Economic Belt. *Transportation Research Part D: Transport and Environment, 57*, 112–123. 10.1016/j.trd.2017.09.005.

Luthra, S., Sharma, M., Kumar, A., Joshi, S., Collins, E., & Mangla, S. (2022). Overcoming barriers to cross-sector collaboration in circular supply chain management: A multi-method approach. *Transportation Research Part E: Logistics and Transportation Review, 157*, Article 102582. 10.1016/j.tre.2021.102582.

Mai, N., Bogason, S. G., Arason, S., Árnason, S. V., & Matthíasson, T. G. (2010). Benefits of traceability in fish supply chains–case studies. *British Food Journal*. 10.1108/00070701011074354.

Miragliotta, G., Perego, A., & Tumino, A. (2009). A quantitative model for the introduction of RFID in the fast moving consumer goods supply chain: Are there any profits? *International Journal of Operations & Production Management*. 10.1108/01443570910993483.

Mohanty, S., Shekhar, P., Sinha, S., Poddar, A., Sahu, G., & Dash, A. (2022). RFID-based patient billing automation using Internet of Things (IoT). *Smart Healthcare Analytics: State of the Art, 207-218*. 10.1007/978-981-16-5304-9_15.

Munoz-Ausecha, C., Ruiz-Rosero, J., & Ramirez-Gonzalez, G. (2021). RFID applications and security review. *Computation, 9*(6), 69. 10.3390/computation9060069.

Musa, A., & Dabo, A. A. A. (2016). A review of RFID in supply chain management: 2000–2015. *Global Journal of Flexible Systems Management, 17*(2), 189–228. 10.1007/s40171-016-0136-2.

Nair, R. S., Agrawal, R., Domnic, S., & Kumar, A. (2021). Image mining applications for underwater environment management-A review and research agenda. *International Journal of Information Management Data Insights, 1*(2), Article 100023. 10.1016/j.jjimei.2021.100023.

Newman-Casey, P. A., Musser, J., Niziol, L. M., Shedden, K., Burke, D., & Cohn, A. (2020). Designing and validating a low-cost real-time locating system to continuously assess patient wait times. *Journal of Biomedical Informatics, 106*. 10.1016/j.jbi.2020.103428.

Nezhad, F. J., Taghizadeh-Yazdi, M., Dahooie, J. H., Babgohari, A. Z., & Sajadi, S. M. (2021). Designing a new mathematical model for optimising a multi-product RFID-based closed-loop food supply chain with a green entrepreneurial orientation. *British Food Journal* ahead-of-print No. ahead-of-print. 10.1108/BFJ-06-2021-0670.

Nguyen, A., Lamouri, S., Pellerin, R., Tamayo, S., & Lekens, B. (2021). Data analytics in pharmaceutical supply chains: State of the art, opportunities, and challenges. *International Journal of Production Research*, 1–20. 10.1080/00207543.2021.1950937.

Núñez-Merino, M., Maqueira-Marín, , J. M., Moyano-Fuentes, J., & Martínez-Jurado, P. J. (2020). Information and digital technologies of Industry 4.0 and Lean supply chain management: a systematic literature review. *International Journal of Production Research, 58*(16), 5034–5061. 10.1080/00207543.2020.1743896.

Oghazi, P., Rad, F. F., Karlsson, S., & Haftor, D. (2018). RFID and ERP systems in supply chain management. *European Journal of Management and Business Economics*. 10.1108/EJMBE-02-2018-0031.

Oliveira-Dias, D., Maqueira, J. M., & Moyano-Fuentes, J. (2022). The link between information and digital technologies of industry 4.0 and agile supply chain: Mapping current research and establishing new research avenues. *Computers & Industrial Engineering*, Article 108000. 10.1016/j.cie.2022.108000.

Oztemel, E., & Gursev, S. (2020). Literature review of industry 4.0 and related technologies. *Journal of Intelligent Manufacturing, 31*(1), 127–182. 10.1007/s10845-018-1433-8.

Pandey, M. K., Mittal, M., & Subbiah, K. (2021). Optimal balancing & efficient feature ranking approach to minimize credit risk. *International Journal of Information Management Data Insights, 1*(2), Article 100037. 10.1016/j.jjimei.2021.100037.

Pantano, E., & Willems, K. (2022). Technological solutions in physical retailing. In *Retail in a new world* (pp. 77–92). Bingley: Emerald Publishing Limited. 10.1108/978-1-80117-846-420221010.

Paul, T., Islam, N., Mondal, S., & Rakshit, S. (2022). RFID-integrated blockchain-driven circular supply chain management: A system architecture for B2B tea industry. *Industrial Marketing Management, 101*, 238–257. 10.1016/j.indmarman.2021.12.003.

Popović, T., Krčo, S., Maraš, V., Hakola, L., Radonjić, S., van Kranenburg, R., & Šandi, S. (2021). A novel solution for counterfeit prevention in the wine industry based on IoT, smart tags, and crowd-sourced information. *Internet of Things, 14*, Article 100375. 10.1016/j.iot.2021.100375.

Pür, S. F., & Sağiroğlu, Ş. (2020). A novel approach to fashion-based analysis and analytics using an intelligent in-store camera system. In *2020 5th International conference on computer science and engineering (UBMK)* (pp. 1–6). IEEE. 10.1109/UBMK50275.2020.9219541.

Rafiquea, M. Z., Haidera, M., Raheema, A., Ab Rahmanb, M. N., & Amjada, M. S. (2022). Essential elements for radio frequency identification (RFID) adoption for industry 4.0 smart manufacturing in context of technology-organization-environment (TOE) framework: A review. *Jurnal Kejuruteraan, 34*(1), 1–10. 10.17576/jkukm-2022-34(1)-01.

Ramasubramaniam, M., & Karthiayani, A. (2022). Traceability systems and technologies for sustainability in food supply chains. In *Lean and green manufacturing* (pp. 103–120). Singapore: Springer. 10.1007/978-981-16-5551-7_6.

Ray, S., Debbabi, M., Allouche, M., Léchevin, N., & Bélanger, M. (2015). Energy-efficient monitor deployment in collaborative distributed setting. *IEEE Transactions on Industrial Informatics, 12*(1), 112–123.

Raza, S. A. (2021). A systematic literature review of RFID in supply chain management. *Journal of Enterprise Information Management*. 10.1108/JEIM-08-2020-0322.

Reyes, P. M., Visich, J. K., & Jaska, P. (2020). Managing the dynamics of new technologies in the global supply chain. *IEEE Engineering Management Review, 48*(1), 156–162. 10.1109/EMR.2020.2968889.

Reyes, P. M., Visich, J. K., Jaska, P., & Roethlein, C. (2021). Inventory replenishment policies for a grocery supply chain using RFID to improve the performance frontier. *Journal of Supply Chain and Operations Management, 19*(1), 52.

Rodger, J. A. (2017). Forecasting of radio frequency identification entropy viscosity parking and forwarding algorithm flow risks and costs: Integrated supply chain health manufacturing system (ISCHMS) approach. *IEEE Journal of Radio Frequency Identification, 1*(4), 267–278. 10.1109/JRFID.2018.2795801.

Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics, 128*(1), 77–95. 10.1016/j.ijpe.2010.07.039.

Sarkar, B. D., & Shankar, R. (2021). Understanding the barriers of port logistics for effective operation in the industry 4.0 era: Data-driven decision making. *International Journal of Information Management Data Insights, 1*(2), Article 100031. 10.1016/j.jjimei.2021.100031.

Savino, M. M., Menanno, M., Chen, X., & Ragno, P. (2018). Exploring the use of RFID in SCOR-based supply chain within ERP environment: A case study for stamps distribution. In 2018 12th International conference on software, knowledge, information management & applications *(SKIMA)* (pp. 1–7). 10.1109/SKIMA.2018.8631521.

Shafique, M. N., Khurshid, M. M., Rahman, H., Khanna, A., & Gupta, D. (2019). The role of big data predictive analytics and radio frequency identification in the pharmaceutical industry. *IEEE Access, 7*, 9013–9021. 10.1109/ACCESS.2018.2890551.

Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., & Purohit, H. C. (2020a). Internet of Things (IoT) adoption barriers of smart cities' waste management: An Indian context. *Journal of Cleaner Production*, Article 122047. 10.1016/j.jclepro.2020.122047.

Sharma, M., Joshi, S., & Kumar, A. (2020b). Assessing enablers of e-waste management in circular economy using DEMATEL method: An Indian perspective. *Environmental Science and Pollution Research, 27*(12), 13325–13338. 10.1007/s11356-020-07765-w.

Sharma, M., Luthra, S., Joshi, S., & Kumar, A. (2020c). Developing a framework for enhancing survivability of sustainable supply chains during and post-COVID-19 pandemic. *International Journal of Logistics Research and Applications*, 1–21. 10.1080/13675567.2020.1810213.

Sharma, M., Luthra, S., Joshi, S., & Kumar, A. (2021). Implementing challenges of artificial intelligence: Evidence from public manufacturing sector of an emerging economy. *Government Information Quarterly, 101624*. 10.1016/j.giq.2021.101624.

Sharma, P., Shah, J., & Patel, R. (2022). Artificial intelligence framework for MSME sectors with focus on design and manufacturing industries. *Materials Today: Proceedings*. 10.1016/j.matpr.2021.12.360.

Sharmila, A., Dhivya Priya, E. L., & Gokul Anand, K. R. (2022). A survey of societal applications of IOT. In *IoT and cloud computing for societal good* (pp. 73–99). Cham: Springer. 10.1007/978-3-030-73885-3_6.

Shiraishi, T., Komuro, N., Ueda, H., Kasai, H., & Tsuboi, T. (2008). Indoor location estimation technique using UHF band RFID. In *2008 International conference on information networking* (pp. 1–5). 10.1109/ICOIN.2008.4472808.

Shree, J., Kanimozhi, N. R., Dhanush, G. A., Haridas, A., Sravani, A., & Kumar, P. (2020). To design smart and secure purchasing system integrated with ERP using block chain technology. In *2020 IEEE 5th international conference on computing communication and automation (ICCCA)* (pp. 146–150).

Sidhu, M. S., Saif, S., Ghazali, N. E., Shah, S. M., Chun, T. W., & Hussain, T. J. (2020). Automating switchgear asset supply chain management with IoT and RFID technology. In *2020 8th International conference on information technology and multimedia (ICIMU)* (pp. 404–408). IEEE. 10.1109/ICIMU49871.2020.9243528.

Sidorov, M., Ong, M. T., Sridharan, R. V., Nakamura, J., Ohmura, R., & Khor, J. H. (2019). Ultralightweight mutual authentication RFID protocol for blockchain enabled supply chains. *IEEE Access, 7*, 7273–7285. 10.1109/ACCESS.2018.2890389.

Singh, R., Singh, E., & Nalwa, H. S. (2017). Inkjet printed nanomaterial based flexible radio frequency identification (RFID) tag sensors for the internet of nano things. *RSC Advances, 7*(77), 48597–48630. 10.1039/C7RA07191D.

Smith, A. D. (2021). Green supply chains and enabling RFID technology. In *Encyclopedia of organizational knowledge, administration, and technology* (pp. 2403–2420). IGI Global. 10.4018/978-1-7998-3473-1.ch166.

Subbulakshmi, N., Chandru, R., & Manimegalai, R. (2022). Transport tracking using RFID and GSM based technique. In *IoT and analytics for sensor networks* (pp. 225–234). Singapore: Springer. 10.1007/978-981-16-2919-8_20.

Svub, J., Stasa, P., & Benes, F. (2020). Application of UHF RFID technology for identification of closely spaced medical equipment. In *2020 IEEE 2nd Eurasia conference on biomedical engineering, healthcare and sustainability (ECBIOS)* (pp. 32–34). IEEE. 10.1109/ECBIOS50299.2020.9203685.

Syed, N. F., Shah, S. W., Trujillo-Rasua, R., & Doss, R. (2022). Traceability in supply chains: A cyber security analysis. *Computers & Security, 112*, Article 102536. 10.1016/j.cose.2021.102536.

Teixeira, E. L. S., Tjahjono, B., Beltran, M., & Julião, J. (2022). Demystifying the digital transition of remanufacturing: A systematic review of literature. *Computers in Industry, 134*, Article 103567. 10.1016/j.compind.2021.103567.

Tian, F. (2016). An agri-food supply chain traceability system for China based on RFID & blockchain technology. In *2016 13th International conference on service systems and service management (ICSSSM)* (pp. 1–6). IEEE. 10.1109/ICSSSM.2016.7538424.

Toyoda, K., Mathiopoulos, P. T., Sasase, I., & Ohtsuki, T. (2017). A novel blockchain-based product ownership management system (POMS) for anti-counterfeits in the post supply chain. *IEEE Access, 5*, 17465–17477. 10.1109/ACCESS.2017.2720760.

Trebilcock, B. (2005). RFID print and ship. *Modern Materials Handling, 60*(1), 31–43. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-12844275009&partnerID=40&md5=d818b959e4ff36383f732bb5bcfc524c .

Umapathi, N., Sabbani, S., & Poovarasan, S. (2022). Person location tracking using global positioning system and ESP8266 with Internet of Things. Futuristic communication and network technologies *211-217*. Singapore: Springer. 10.1007/978-981-16-4625-6_21.

Ustundag, A., & Tanyas, M. (2009). The impacts of radio frequency identification (RFID) technology on supply chain costs. *Transportation Research Part E: Logistics and Transportation Review, 45*(1), 29–38. 10.1016/j.tre.2008.09.001.

Verma, S., Sharma, R., Deb, S., & Maitra, D. (2021). Artificial intelligence in marketing: Systematic review and future research direction. *International Journal of Information Management Data Insights, 100002*.

Wamba, S. F., Anand, A., & Carter, L. (2013). A literature review of RFID-enabled healthcare applications and issues. *International Journal of Information Management, 33*(5), 875–891. 10.1016/j.ijinfomgt.2013.07.005.

Wang, C.-S., Chen, C.-L., & Guo, Y.-M. (2013). A real-time indoor positioning system based on RFID and Kinect. In *Information technology convergence* (pp. 575–585). Springer. 10.1007/978-94-007-6996-0_61.

Xiao, Q., Chen, S., Chen, M., Zhou, Y., Cai, Z., & Luo, J. (2017). Adaptive joint estimation protocol for arbitrary pair of tag sets in a distributed RFID system. *IEEE/ACM Transactions on Networking, 25*(5), 2670–2685. 10.1109/TNET.2017.2709979.

Xiao, Z. (2021). Design of automatic recharging system of robot based on RFID radio frequency technology. In Recent advances in electrical & electronic *engineering (formerly* recent patents on electrical & electronic engineering*): 14* (pp. 67–74). 10.2174/2352096513999200710141148.

Xie, P., & Rui, Z. (2010). Research on application of enabling technologies in management system for third-party logistics. In *2010 International conference on intelligent computation technology and automation: 2* (pp. 1089–1093). 10.1109/ICICTA.2010.175.

Xu, Z., Ming, X. G., Zhou, J., Song, W., He, L., & Li, M. (2013). Management optimization based on dynamic SKU for RFID-enabled warehouse management in the steel supply chain. *International Journal of Production Research, 51*(10), 2981–2996. 10.1080/00207543.2012.751513.

Yan, P., Choudhury, S., & Wei, R. (2020). A Machine learning auxiliary approach for the distributed dense RFID readers arrangement algorithm. *IEEE Access, 8*, 42270–42284. 10.1109/ACCESS.2020.2977683.

Yang, M., Fu, M., & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change, 169*, Article 120795. 10.1016/j.techfore.2021.120795.

Yang, X., & Dong, X. (2011). *Dynamic monitoring system based on RFID technology for workshop production* (pp. 1331–1334). MSIE. 2011. 10.1109/MSIE.2011.5707669.

Zeng, J., & Wang, J. (2011). Optimize supply chain management applying active RFID technology. In *2011 International conference on computer science and service system (CSSS)* (pp. 543–545). 10.1109/CSSS.2011.5972182.

Zhang, Y., & Wang, Z. (2018). Optimal RFID deployment in a multiple-stage production system under inventory inaccuracy and robust control policy. *IEEE Transactions on Industrial Informatics, 15*(6), 3230–3242. 10.1109/TII.2018.2878638.

Zhu, L., Wang, X., Yang, Y., Xu, S., Wu, X., Zhao, W., & Feng, H. (2020). Epc-based efficient tag selection in RFID systems. *IEEE Access, 8*, 20546–20556. 10.1109/ACCESS.2020.2969188.

Zuo, Y., Yada, K., Li, T., & Chen, P. (2018). Application of network analysis techniques for customer in-store behavior in supermarket. In *2018 IEEE international conference on systems, man, and cybernetics (SMC)* (pp. 1861–1866). 10.1109/SMC.2018.00322.