A

PROJECT REPORT

ON

"IoT in Supply Chain Management and Logistics"

UNDERTAKEN

IN PARTIAL FULFILLMENT OF POST GRADUATE EXECUTOVE DIPLOMA IN

GLOBAL SUPPLY CHAIN MANAGEMENT & LOGISTICS

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DECLARATION

I hereby declare that this project report entitled “IoT in Supply Chain Management and Logistics” is a bonafide record of the project work carried out by me during the academic year 20_-20_, in fulfilment of the requirements for the award of POST GRADUATE DIPLOMA IN GLOBAL SUPPLY CHAIN MANAGEMENT AND LOGISTICS of MIT School of Distance Education.

This work has not been undertaken or submitted elsewhere in connection with any other academic course.

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ABSTRACT (Executive Summary)

Summary: Supply Chain Symphony with IoT Fusion

In the complex symphony of modern business, Supply Chain Management (SCM) is the leader that unifies the flow of goods and services. However, the introduction of the Internet of Things (IoT) has brought a new pace to this instrumentation, unlocking unprecedented connectivity and efficiency.

Introduction: Introducing the IoT-SCM Nexus

In today's retail aisles, the fusion of IoT technology and SCM practices has emerged as a revolutionary force. This symbiotic relationship between IoT and SCM not only increases operational efficiency, but also reveals opportunities to improve visibility and optimize costs.

Organizational Profile: Navigating the IoT Horizon

The Internet of Things, which is like a digital tapestry woven into threads of interconnected devices and systems, has shaped the industrial landscape. Driven by the Industrial IoT (IIoT), SCM has undergone a profound transformation in the automation of machine-driven tasks, embracing a new era of data-driven decision-making and seamless operations.

Goals and Scope: Building an SCM Renaissance

IoTand#039 At the core of SCM integration is the effort to overcome multifaceted challenges from transportation costs to changing consumer needs. Through IoT solutions, organizations are embarking on a transformational journey towards agility, transparency and sustainability in their supply chain ecosystems.

Data Analysis and Interpretation: Impact of IoTand#039 Decoding on SCM dynamics

IoTand#039's ability to transform SCM dynamics is nothing short of revolutionary, providing real-time traceability, predictive line maintenance and last mile. By leveraging the insights gained from the Internet of Things, organizations are discovering new perspectives in operational efficiency and competitive advantage.

Challenges and Solutions: Disruptive IoT Solutions

Navigating the labyrinthine challenges of SCM operations, IoT emerges as a beacon of innovation. With customized IoT-based solutions, organizations navigate through complexity and orchestrate a symphony of efficiency and excellence in their supply chain networks.

Benefits of IoT in Logistics and Supply Chain: Unlocking the Possibilities

The benefits of IoT integration in SCM are as varied as the threads of a living tapestry, from automation and real-time monitoring to improved visibility and transparency. customer relationship management. With IoT as the main star, organizations are moving towards predictive logistics and unparalleled efficiency.

Conclusion: The Overture of IoT in SCM

Finally, the integration of IoT in SCM is not just an evolution, but a symphonic growth of innovation and progress. By adopting a harmonious combination of IoT-based solutions, organizations embark on a journey to a future where efficiency, sustainability and customer centricity form the cornerstone of supply chain excellence in the ever-evolving pace of modern business.

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CHAPTER 1 : Introduction

Supply Chain Management (SCM) involves the effective management and optimization of various aspects of the supply chain processes of goods and services. In today's world, SCM has benefited significantly from the continuous growth of the Internet of Things (IoT) industry. The integration of IoT technology enables the automation and digitization of supply chain processes, which improves operational efficiency and lowers operating costs.

The widespread adoption of IoT devices has transformed supply chain management. These devices play a key role in tracking and tracing shipments in real time using advanced tracking technologies such as GPS. In addition, IoT devices are used for asset management using NFC technology and RFID tags. Essentially, IoT devices find application in almost every step of the supply chain process.Although IoT-based SCM is continuously researched and many technical publications are published, systematic literature reviews (SLRs) on the subject are remarkably scarce. This article aims to address this knowledge by introducing SCM with a focus on IoT-based SCM by providing a comprehensive literature analysis from 2018 to 2022. The review covers various aspects of IoT-based SCM, including application areas, technologies and sensors and devices used to implement IoT-based SCM systems. The results of SLR aim to benefit future researchers and practitioners interested in IoT-based SCM by providing a comprehensive literature review and valuable insights into the challenges, benefits, and economic and business implications of this technology.The emergence and widespread adoption of IoT is bringing innovation to modern supply chains and offers the potential for change.

The use of IoT-compatible technologies, devices and sensors has become central to optimizing various aspects of supply chain processes. Despite the proliferation of IoT in supply chain management (SCM), there are no comprehensive reviews that provide a detailed analysis of IoT-based SCM. To address this knowledge, this study conducts a systematic literature review (SLR) focusing on IoT-based SCM. This section explores the background of IoT and SCM and highlights the incorporation of IoT into SCM practices. In addition, a brief overview of relevant literature reviews is provided and a spotlight is placed on important research in the field.

Founded in 1963, the Council of Supply Chain Management Professionals (CSCMP) is dedicated to promoting a platform for community participation and professional collaboration in supply chain and logistics. CSCMP defines Supply Chain Management (SCM) as encompassing all planning and control of procurement and supplier activities, conversion and various logistics management functions. This definition also emphasizes the importance of coordination and collaboration with channel partners, suppliers, intermediaries, third-party service providers and customers, integrating supply and demand management both within and between companies..

The SCM process begins with procurement of raw materials, where the suppliers responsible for manufacturing the products obtain the necessary raw materials. Manufacturers then process these raw materials and produce finished products. After the manufacturing stage, the products are

distributed through wholesalers. These wholesalers then sell the products to retailers and consumers usually buy from the retailers..

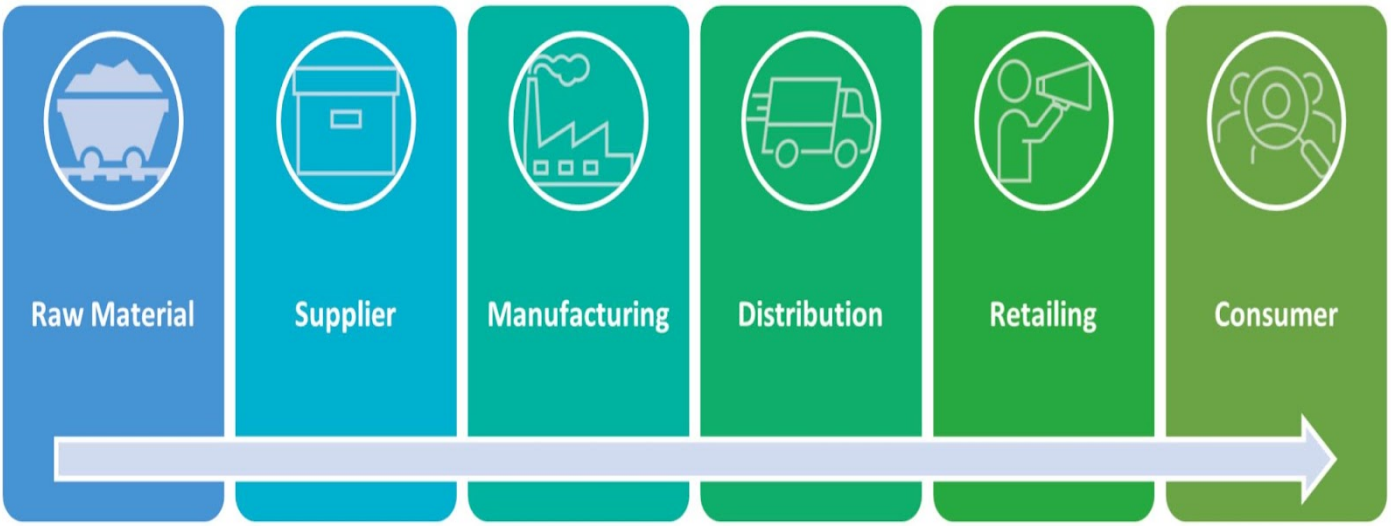

Figure 1

CHAPTER 2 : Organization profile

About IoT :

The term "Internet of Things" (IoT) was first introduced by Kevin Ashton in 1999 in a presentation on supply chain management. IoT aims to create advanced connections between devices, systems or services to enable automation. It requires all things to be connected, allowing them to communicate over different protocols and domains.

Two-way communication between the physical and digital worlds is an essential part of the Internet of Things.In the Internet of Things andquot;thingandquot; can refer to different entities, such as a person with a heart monitoring implant, a pet with a biochip transponder, or a car with built-in sensors. These objects can be assigned an IP address that allows them to transmit data over the network.Various definitions of IoT have been proposed, some emphasizing connectivity and sensory requirements, while others focus on the need for networks of ubiquitous and autonomous objects.

The McKinsey Global Institute defines IoT devices as devices that can monitor their environment, report their status, receive instructions and act on the information they receive.Industrial IoT (IIoT) is a special application of the Internet of Things favored by large high-tech companies. IIoT involves machines performing tasks such as collecting data and communicating more accurately than humans. Machine-to-machine (M2M) communication, big data analytics and machine learning are integral parts of the IIoT, enabling companies to identify and solve problems faster, saving cost and time..

IoT covers a wide range of applications including healthcare, utilities, transportation, agriculture, etc. It aims to enable computer recognition without human intervention, thus transforming the current Internet into a network of interconnected objects. andquot;Intelligenceandquot; is a characteristic feature of the Internet of Things, classified as "object intelligence"; and andquot;network intelligence.andquot;Another main task of IoT is to create a collaborative system that can effectively respond to events recorded by sensors, searching and communicating information from different fields.

IoT has the potential to revolutionize the medical and business sectors by expanding communication channels, facilitating automation and control, and reducing overall deployment and maintenance costs.As IoT becomes more common, attackers are shifting their focus from servers to end devices due to factors such as physical accessibility, the increased number of vulnerable devices, and the distributed nature of IoT, which complicates the remediation process..

CHAPTER 3 : Objectives and Scope : Why Choose IoT for Supply Chain Management?

When people hear about the Internet of Things (IoT), people often turn to electronics or wearables and envision technologies that drive personalized and intelligent consumer lifestyles. However, the impact of IoT goes far beyond these areas, especially regarding its impact on the supply chain. Leading research firm Gartner recently highlighted the imminent logistical disruption caused by a projected 30-fold increase in the number of physical devices connected to the Internet by 2020.

This growth is expected to significantly change supply chain operations, particularly in how supply chain managers access information.While enterprise resource planning (ERP) and supply chain management (SCM) are closely intertwined, the IoT revolution is poised to take these solutions to the next level – think of it as SCM 2.0. The deeper intelligence enabled by the IoT can manifest itself in supply chain data and intelligence in many different ways, from automating manufacturing processes to better visibility in warehouses.Supply chains operate in a constantly changing environment and are exposed to varying levels of vulnerability. Factors such as large geographic areas, global risks, changing customer demands, increasing product complexity and dynamic external conditions contribute to a complex landscape.

To survive successfully in this complex environment, companies must be exceptionally agile and build a high level of agility and risk management capabilities to be structurally flexible. Christopher and Holweg define structural flexibility as the ability of a supply chain to adapt to fundamental changes in the business environment. Balancing the required resilience and flexibility with the associated costs requires high visibility throughout the supply chain, quick responsiveness and effective collaboration with suppliers and customers..

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Significance of IoT in SCM :

The traditional supply chain management (SCM) process struggles with a number of issues such as overstocking, understocking, delivery delays, and real-time information dissemination issues. Implementing effective and well-defined SCM processes can significantly improve operational efficiency and profitability. Technological advances have led companies to adopt the latest SCM technologies, especially with the advent of the Internet of Things (IoT), which has led to smarter and better SCM processes. Incorporating IoT into SCM brings out special features:

- Instrumented: IoT-based SCM relies on machine-generated data, such as sensors, that collect extensive environmental data.
- Connected: The Internet and IT systems enable the connection between intelligent objects, business units, products and resources in the SCM process.
- Smart: Business Intelligence and intelligent analysis optimize decision-making in the SCM process.
- Automated: The entire SCM process is automated, improving efficiency and usability and minimizing labor-intensive tasks.
- Integrated: IoT-based SCM includes a set of interconnected processes. Collaboration between different stages enables joint decision-making and sharing of information.
- Innovative: Integrating IoT into SCM leads to new solutions that meet today's needs and drive change and value.

The image below illustrates the characteristics of IoT-based SCM and shows the revolutionary impact of IoT on various stages of SCM, including manufacturing, warehousing, transportation and logistics. IoT promotes automation, cost efficiency, product traceability, better inventory management, machine performance and market trend visibility at every stage, ultimately facilitating business growth.

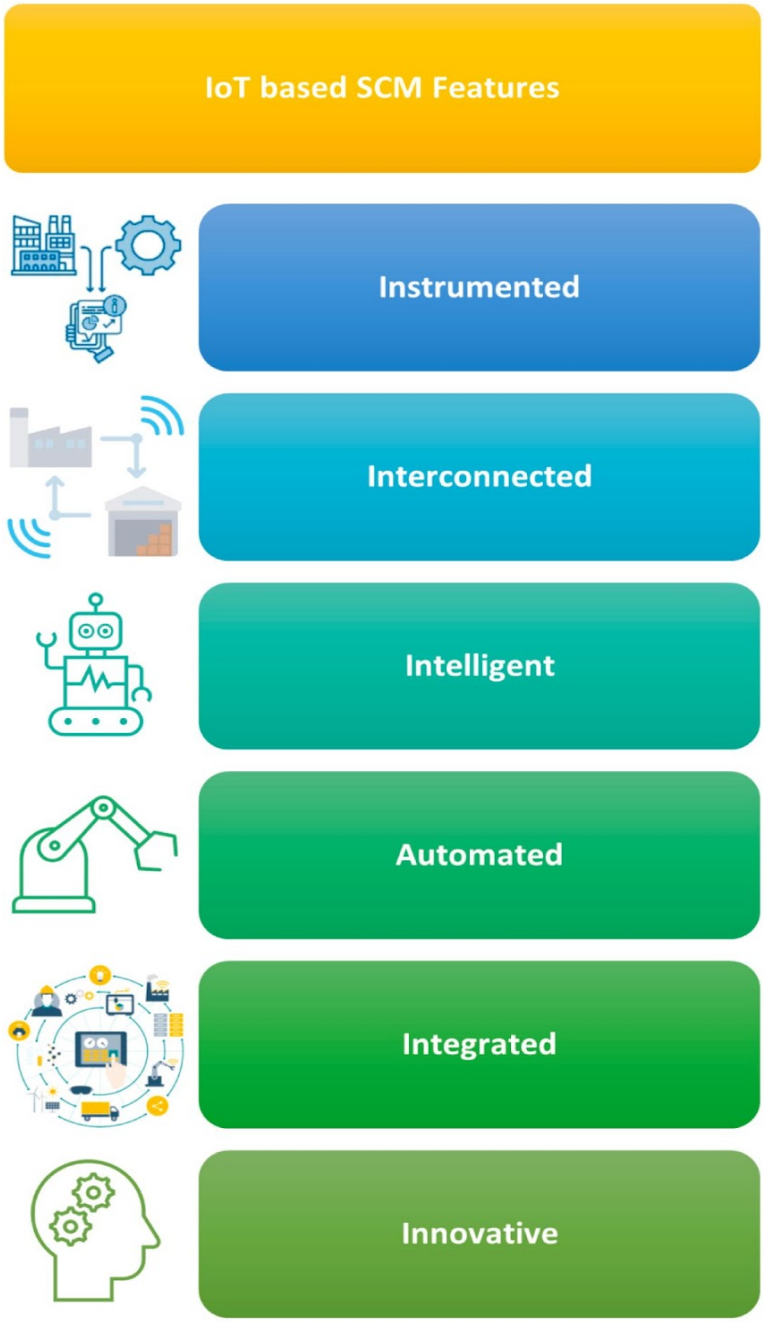

Figure 2

Like many other industries, supply chains and logistics are evolving. Both supply chain and logistics face new challenges due to disruptive technological innovation, strict government regulations and increasing customer expectations.

If you don't address these issues directly and ignore them, they can soon become major pain points for you.

CHAPTER 4 : Data Analysis and Interpretation :

How IoT Enhances SCM Efficiency

Information technology integration plays a key role in effective supply chain quality management, which emphasizes the importance of timely information exchange in quality control. Innovative technologies that can be incorporated into a supply chain quality control system include service-oriented architecture, RFID, agents, workflow management, and cross-organizational integration. RFID, a technology related to the Internet of Things (IoT), significantly improves the flow of information in the supply chain.

By leveraging RFID and other technologies, supply chain partners can use shared data for quality control, facilitating real-time traceability and simplifying workflow integration.Lee identifies three key components that enable a device to acquire information about its environment, think and communicate: sensors, connectivity and processors. In addition, Lee highlights nine areas where IoT and SCM can successfully coexist, from supply chain transparency and visibility to advanced fleet management. The transparency and full visibility provided by IoT creates new opportunities for supply chain professionals to optimize operations and create value.The promise of IoT is an interconnected network of uniquely identifiable smart objects that form the framework for various applications. From logistics and transportation to healthcare systems, smart cities and disaster management, the application field of IoT is vast and spans multiple industries.

Device monitoring through APIs provides valuable information about energy consumption, device performance and sensor status, enabling real-time reporting and actions without physical access. Smart metering and smart grids help detect errors and optimize energy consumption, which ultimately increases productivity.With billions of connected devices, identity management and authentication methods are critical to building trust. Consumers, data sources and service providers in the IoT ecosystem require secure connections, which affect the time to build trust and the level of trust..

Different mechanisms such as ukode, 128-bit code generation for active and passive RFID tags, and Electrical Product Code (EPC) with Uniform Resource Identifier (URI) codes are important to ensure unique identification of devices or objects in IoT.

Domains of Application for Research in IoT-Based Supply Chain Management :

This section examines the various application areas of IoT-based supply chain management (SCM) research, which include the following areas:

- **Supply Chain of Additive Manufacturing:** Supply Chain of Additive Manufacturing, commonly known as 3D printing, represents a recent breakthrough in the manufacturing industry. The Additive Manufacturing Supply Chain has gained traction and become more secure and traceable thanks to the integration of IoT and Blockchain technologies.

- **Agriculture and Food Supply Chain:** The agriculture and food supply chain includes the supply of raw crops and food to producers and retailers, and farm-to-table operations. As technology advances, IoT-based solutions automate and improve traceability, safety and reliability in agriculture and food chains, and respond to challenges such as spoilage and food waste.
- **Asset Supply Chain:** Assets have significant value to organizations and Asset SCM is used to track and manage these assets. The asset supply chain process includes activities such as asset registration, inspection and maintenance, and tracking and distribution.
- **Cold supply chain:** cold supply chain operates in a temperature controlled environment, mainly for products such as food, vaccines and pharmaceuticals. This supply chain manages the production, storage and delivery of these temperature-sensitive products, ensuring a continuous low temperature.
- **E-commerce Supply Chain:** E-commerce supply chain involves the strategic management of all e-commerce related activities, which include raw material production, manufacturing, logistics, warehouse management and last mile delivery to the end customer, among others.
- **Medical and Healthcare Supply Chain:** The medical and healthcare supply chain manages medical and healthcare operations, including the production and distribution of medical supplies and medicines to patients.
- **Reverse supply chain:** A reverse supply chain reverses the traditional supply chain process and deals with the return of products from customers to manufacturers. This process manages returned products through reuse or disposal.
- **Electric Vehicle Supply Chain:** The Electric Vehicle Supply Chain is a forward-looking system designed to manage and track electric vehicles.

Figure 3

List of challenges that need quick actions across the supply chain and logistics companies:

1. Rising transportation costs

One of the biggest challenges facing the logistics industry is cutting the rising costs of transportation. Logistics costs can easily reach 50% of total costs in some industries, and rising fuel prices exacerbate this problem.

There is no doubt that higher fuel/diesel prices have a direct impact on transport costs. And rising fuel prices increase the surcharges added to freight rates.In addition to high fuel and freight costs, other factors affect logistics operating costs, such as more global customers, the use of advanced technology, increased labor costs and rising prices of raw materials.

2. Redundant business processes

Logistics/supply chain companies are under pressure to find creative ways to plan, strategize, deliver services and improve business processes such as delivery rate, capacity utilization, cost efficiency and competition.In addition to the need for innovative technology, logistics companies must stay abreast of new business process changes that eliminate inconsistencies.

This type of process improvement can help you provide better service to your customers and make your operations more efficient.

However, it is expensive and difficult for companies to implement and implement these improvements without help.

3. Changing customer expectations

Changing customer demands and maintaining sustainable customer relationships are essential for logistics.Customers expect complete transparency and visibility into where their supply is at all times. In addition, a smooth process from order to delivery is expected.

While your customers understand the complexities involved, they expect the service provider to manage everything in a timely but cost-effective manner.Customers' willingness to pay extra for fast delivery has decreased despite high service expectations. 64 percent of survey respondents said they are not willing to pay extra for less than two-day delivery.

As a result, logistics companies are under pressure to deliver a superior and unparalleled customer experience without compromising on time and money.

4. Impact on the economy

The logistics sector directly connects manufacturing and consumer industries and facilitates trade. However, rising inflation and high fuel prices lead to a credit crunch and affect economic growth.

In addition, the political scenario, declining activity of the manufacturing industry, and CPI affect the demand for products/services and further affect the demand for freight transport..

5. Cash flow management

Managing Cash Flow

Cash flow management is a pressing issue in most businesses, especially in logistics and supply chain.Cash flow is no longer easily predictable. As global supply chain capacity shrinks and demand and supply prices rise, all stakeholders—carriers, shippers, and sellers—are under pressure for faster cash flow and slower cash withdrawals.

Companies need to implement long-term changes that will help them better manage cash flow. However, it is not easy to know where and when to allocate resources when several different entities are operating simultaneously.

For example, if you spend $10,000 on materials, you need to know how much it costs to transform them into products and deliver them to customers. This process includes shipping, warehousing, manufacturing, packaging, distribution and more..

6. Inventory Control and Visibility

Every logistics company wants to know what inventory it has and where it is at any given time.This can be critical to your business, but gaining visibility and control over your inventory can be difficult.

Poor inventory management results in incomplete, inaccurate and late deliveries..

7. Driver shortage and retention

Did you know that more than 68 percent of all loads on American highways are carried by truck drivers?

In 2018, the transport sector confirmed a shortage of 60,800 drivers, which is almost 20% more than the 50,700 reported in 2017. At this trend, the shortage could swell to around 160,000 by 2028. (Source)During unemployment is high, the lack of managers is a major problem.

Shippers and carriers are struggling with the need and retention of commercial drivers.Sure, you can blame it on factors like the demographics of the current workforce and managers, and #039; lifestyles, but this absence affects executive salaries.

This has significant implications for supplier costs, consumer prices, delivery delays and store shortages.

8. Implementing technology developments

Although most supply chain companies are aware of the requirement to carry out technological development in order to survive in the competition, the cost of adapting to innovative technology is very high.

IoT and other digital solutions with AI/ML, drones and robots are a great way to move forward in the traditional supply chain.All this can make your electronic processes better, more efficient and more cost effective.

But the real challenge is implementing them in the company's current supply chain.Because the implementation of these technologies requires time and organizational restructuring, especially if you work with multi-store and multi-channel sales.

9. Accountability and compliance

Supply chain companies doing international business must be wary of social demands.Many factors, such as child labor, poor working conditions and unfair labor compensation, contribute to unethical practices in global supply chains.

While there are ways to ensure that supply chain partners adhere to ethical standards, care must be taken.The risks associated with such matters are high - potential brand damage and legal action.

Staying ahead of these challenges may seem overwhelming to you; However, with the right solutions and technologies, you can overcome these obstacles and make your business even more efficient.IoT integration can improve the efficiency of your supply chain and logistics business.

Here are five innovative approaches to leverage IoT technology for enhancing operational excellence:

Enhancing Inventory Management

Supply chain companies doing international business must be careful In traditional supply chains, managing large volumes of small orders can be difficult, and forecasting future business demands is often difficult.

The IoT-compatible storage systemprovides real-time information about the status of the warehouse, which enables informed decisions and prevents product shortages.

Predictive analysis of IoT data predicts future storage needs and tracking physical factors such as leaks or damage is seamless. Build a smart warehouse using IoT to manage your warehouse remotely, avoid excess inventory, monitor delivery levels and item..

Promoting Transparency

Transparency between supply chain parties is critical for businesses, and IoT plays a key role in increasing transparency and minimizing disruption.

IoT implementation enables real-time tracking of drivers, shipments and enforcement of internal policies. Real-time access toinformation ensures transparency of storage conditions and timely communication with end customers, which promotes better customer relations.

Optimizing Last-Mile Deliveries

Last mile deliveries, which represent a significant part of supply chain costs, can be improved with IoT technologies.

Use GPS and IoT to identify optimized routes, minimize fuel consumption and waste time in traffic using real-time traffic analysis and notifications..

Efficient Fleet Management

Equip your fleet with IoT sensors to monitor maintenance levels in real time and receive timely updates on driver health and traffic conditions.

Implementing IoT in fleet management strategies can lead to reduced fuel costs and simplified vehicle maintenance.

Adopting Predictive Maintenance

Move beyond traditional preventive maintenance with IoT for predictive maintenance.

IoT sensors monitor equipment health and send real-time information to inventory management software, alert when maintenance is needed, preventing downtime and equipment failure..

Benefits Of IoT For Logistic & Supply Chain Management

1. Automation

Automation plays a strong role in all companies in modern industry. This helps control manual tasks and labor costs and reduce human error.

4,444 With the help of IoT devices, the speed of resource delivery succeeds. It helps manufacturers by controlling industrial procedures.

Businesses can also use IoT-enabled drones to manage inventory and build advanced infrastructure..

2. Real-Time Tracking

Another important thing about IoT is that they have special sensors that enable data collection. These tools deliver and analyze data in real time.

Such features of IoT devices make the transportation and supply chain easier and more manageable. It helps organize information immediately and directly.

IoT technologies for supply chain management allow experts to track goods and their condition and order status instantly..

3. Transparency

IoT devices can provide optimal transparency. It continuously monitors the complete information and performance of raw and finished products. You can check the stock and inventory of warehouse management at any time.

IoT devices monitor delivery products and review reports and track shipment progress using IoT GPS solutions.

In this way, the Internet of Things offers a strong assurance of logistics and supply chains to avoid uncontrolled operations and costs.

4. Speedy Process

The speed of operation and delivery has a strong impact on the overall production of the company's growth.

IoT for supply chain companies automates the streamlining of SCM and accelerates the following activities.

By centralizing and consolidating IoT supply chain management, the company can accelerate the work of other departments.

5. Resource Management Efficiency

IoT solutions help manage the supply of resources and organize the distribution of products in the most productive way.

An IoT inventory management system automates analytical reports that show information such as which materials are low in inventory, resources to be delivered, and the status of price changes.

IoT supply chain can detect resource leaks in seconds and maintain reservation seamlessly. It monitors and blocks inefficient points that can lead to potential failure of your device..

6. Asset Tracking

IoT devices can be used to facilitate asset management. Thanks to advanced IoT devices such as sensors, smart materials, RFID tags, etc., it is possible to track the location and condition of each object.

With the help of such technologies, experts immediately receive important information about the supplied material and product..

7. CRM Improvement

Supply chain IoT logistics and solutions benefit managers and customers. There are several companies that present an innovative customer app to their customers where they can track their order status and shipment using GPS.

Customers can track the delivery of goods to their door. In this way it creates a reliable and strong relationship with customers..

8. Predictable Logistics

IoT developers offer a number of GPS trackers and responsive tools to track shipments. With IoT logistics solutions, experts can predict their delivery times. It also defines the consequences of delivery delays.

Modern logistics IoT helps to analyze existing data and monitor weather conditions. In addition, you can also anticipate possible traffic jams, send risk notifications and recommend ideal routes.

After all these advantages, the device also brings IoT challenges in supply chain and logistics, which we discuss in the section below..

Role Of The Supply Chain In The Industry Of Agriculture

Here are some common examples of how supply chain IoT is driving agricultural production and distribution businesses!

1. IoT devices help collect information about agricultural farms. It can automate inventory management and alert you with an alarm when inventory is low!
2. IoT Supply Chain Sends Alerts When Container Condition Does Not Meet Specified Requirements. It alerts officials when they detect an error in temperature control and food safety laws.
3. IoT remote monitoring enables efficient and cost-effective equipment repair/maintenance planning and scheduling.supply chain and logistics, which we discuss in the section below..

Using IoT In The Inventory Management

Integrating IoT tools into inventory management is a critical decision. IoT devices help organize and improve all stages of the supply chain. Thanks to advanced facilities, these systems ensure that

raw material transports and deliveries reach customers and distributors on time. Determining the importance of asset management in supply chain management is difficult

.Some of the key use cases for IoT in inventory management include:Due to the intelligent distribution capabilities of IoT devices, it can limit error management.

1. The IoT device helps refine calculations for raw materials and finished products.
2. Enterprises are using IoT devices to improve procedures and identify recurring patterns.
3. IoT device warehouse integration enables real-time data updates to be delivered. This helps track availability and prevents unfulfilled orders.

IoT In The Industry Of Transportation

You can collect all the information about transport links with IoT devices and connect the supply chain. Whether it's trucks, cargo or ocean containers, the Internet of Things makes supply chain transportation easier. With IoT, the industry can promote transparency and improve logistics operations.

Here are some concrete examples of IoT use cases in the transportation industry.

1. Shipment routes can be displayed in real time by Logistics IoT devices. These tools can maximize resource efficiency as well as improve delivery speed.IoT devices help vendors, customers and suppliers communicate and share information more effectively. With this, the transport business can anticipate changes in transport orders.
2. IoT logistics tools can identify and correct errors. It also monitors temperature and follows safety protocols.

Examples of IoT Transforming Supply Chain and Logistics:

Amazon's Warehouse Automation

Amazon utilizes 100,000 IoT robots across 493 warehouses globally, enhancing efficiency in inventory management.

Acquisition of Kiva Robots in 2012 further automated warehouse operations, allowing robots to navigate pre-programmed paths, reducing the need for manual labor.

NJTA – Improved Traffic Management

The New Jersey Turnpike researcherity collaborates with IBM to implement IoT for vehicular traffic management.

IoT sensors generate data used by emergency services and traffic management operators to respond faster to accidents, reducing congestion.

Volvo's IoT-Enabled Container Ships

Volvo embraces IoT to fully automate container ships, minimizing human intervention during travel between ports.

A cloud platform connects people and logistics, allowing containers to slow down automatically upon reaching their destination and facilitating seamless unloading.

Embrace the transformative power of IoT to streamline your supply chain and logistics operations, following in the footsteps of industry leaders like Amazon, NJTA, and Volvo.

Maersk Line - Intelligent Cargo Containers

Maersk, a renowned global shipping entity, employs innovative IoT-enabled cargo containers equipped with smart technology. These containers offer real-time insights into crucial factors such as temperature, humidity, and location, ensuring the secure transportation of sensitive goods like pharmaceuticals and perishables. Through vigilant monitoring during transit, Maersk effectively prevents spoilage, lowers insurance claims, and strengthens customer confidence.

Walmart - RFID-Driven Inventory Management

Walmart employs cutting-edge Radio Frequency Identification (RFID) technology to revolutionize its inventory tracking system. Each item is equipped with an RFID chip, facilitating automated and precise inventory monitoring. This technological advancement has significantly enhanced inventory accuracy, minimized instances of out-of-stock products, and streamlined the overall replenishment processes.

Amazon - Advanced Warehouse Optimization through Predictive Analysis

Amazon's state-of-the-art warehouses, powered by the Internet of Things (IoT), utilize sensors to gather comprehensive data on inventory movement, order fulfillment rates, and employee activities. Harnessing the power of predictive analytics algorithms, Amazon accurately forecasts

demand patterns. As a result, the company optimizes inventory levels, reduces storage costs, and expedites order processing with unparalleled efficiency.

Coca-Cola - Intelligent Beverage Dispensing Solutions

Coca-Cola's innovative vending machines leverage IoT technology to monitor key metrics such as stock levels, sales trends, and machine functionality. When supplies run low, these smart devices autonomously generate restocking requests, ensuring a proactive approach to replenishment. This strategy effectively reduces instances of empty machines, maintains consistent product availability, and contributes to heightened customer satisfaction.

Main technologies used for IoT-based SCM

1. Artificial Intelligence (AI)

Artificial Intelligence (AI) AI is the most powerful IoT enabling technology that can be used to automate the SCM process. Artificial intelligence can help key SCM stakeholders such as managers, suppliers and retailers with predictive analysis and failure detection in their products.

The researchers used the power of artificial intelligence to analyze damaged product models. The researchers have developed an intelligent algorithm that highlights defective products and serves them for safety shares. Defective products are checked by an artificial intelligence algorithm and returned to the seller. Backorders are orders for a certain type of product that cannot be filled or fulfilled at this time because the product is not available due to a lack of supply. To solve this problem, the researchers used artificial intelligence machine learning techniques to predict subsequent orders for specific products.

The researchers participated in the optimization of the SCM process. All shareholders, suppliers, managers and retailers require a lot of forecasting. Solving the retention problem with AI will ultimately increase customer trust and help grow the business. The researchers identified optimal routes using artificial intelligence to improve vehicle logistics. The researchers used artificial intelligence techniques to find alternative optimal delivery routes to avoid delays in shipping urgent products. Fuzzy logic is a rule-based artificial intelligence technique applied to decision making. The researchers measured the occupational safety risk of cold chain factory workers according to their health status using fuzzy logic. The researchers developed an agent-based system using RFID and cloud technology. This agent-based system provides an intelligent shelf service that can recommend desired products to customers and provide real-time product information to facilitate dynamic response to customer demand and market changes, especially for hot selling products.

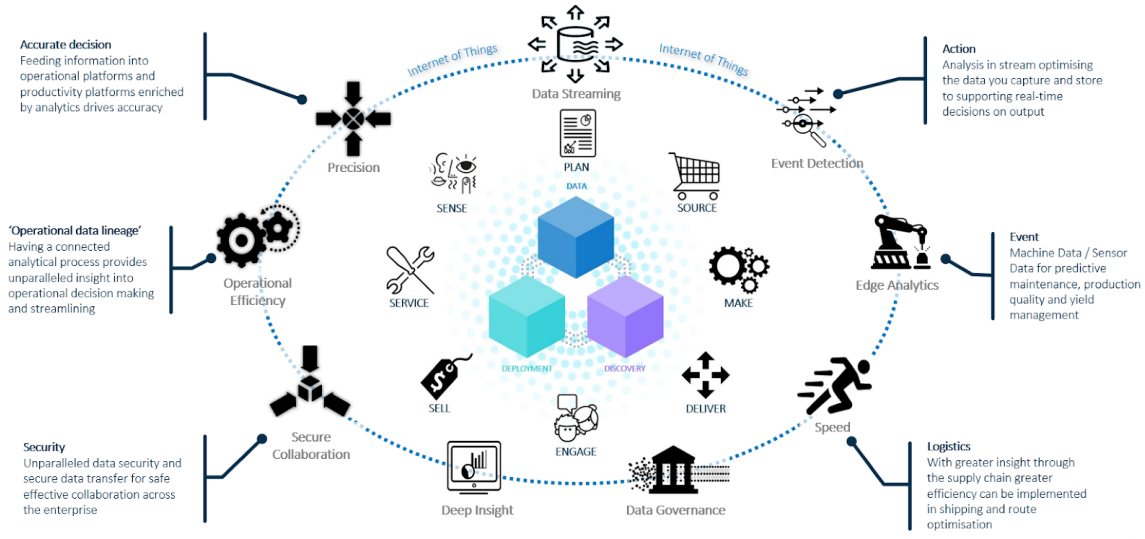

Figure 4

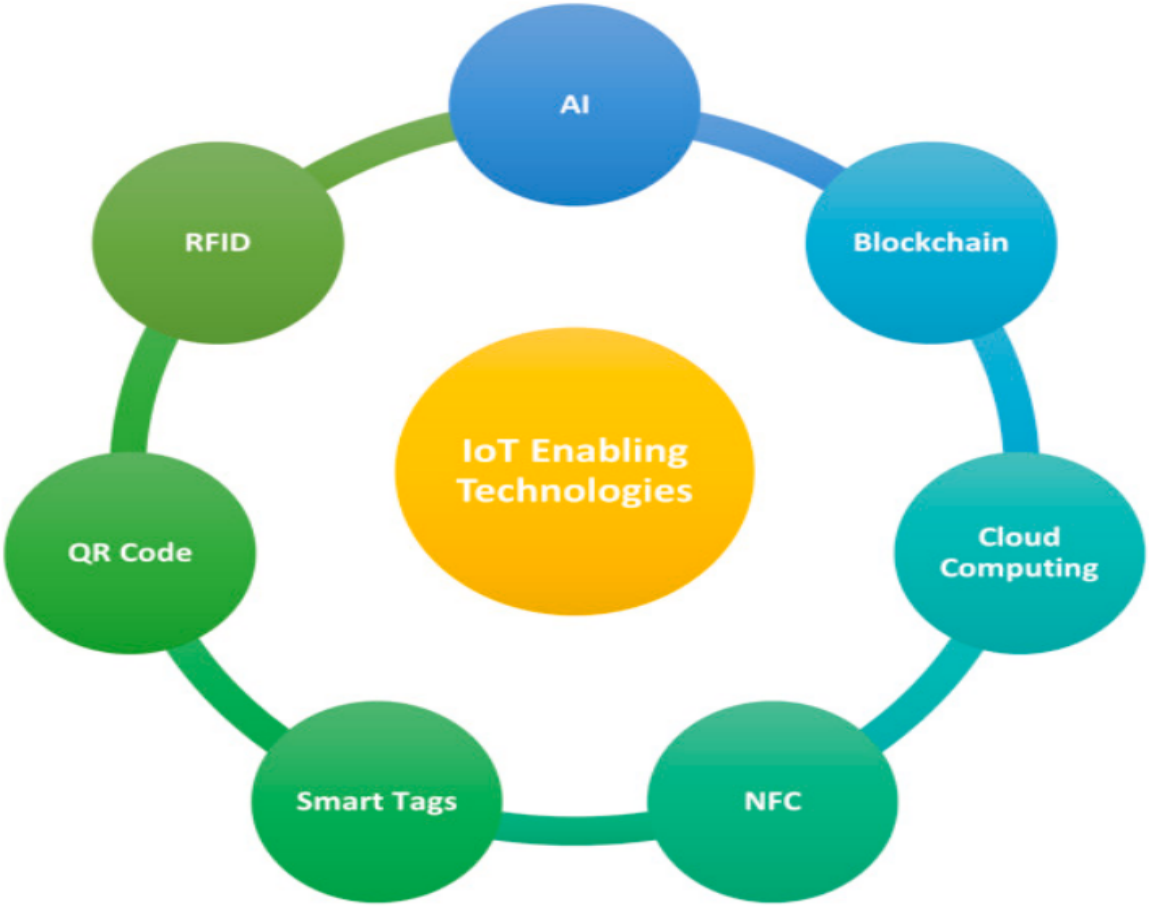

Figure 5

2. Blockchain Traditional IoT-based SCM

Blockchain Traditional IoT-based SCM suffers from transaction problems that cannot be verified. Product traceability is difficult. Therefore, Blockchain is the best solution to these problems. Blockchain can make IoT-based SCM secure, transparent and auditable. The researchers created a blockchain-based framework for the traceability of electronic supply chains, especially for the traceability of microelectronic chips and off-the-shelf (COTS) parts used in electronic devices. They used Hyperledger to implement the proposed framework. This framework helps all manufacturers, distributors and customers track and trace the origin of electronic components to protect themselves from counterfeit electronic devices.

Traditional food tracking systems are centralized and subject to falsification of their data and disclosure of sensitive information. In order to provide a safe and reliable solution for the food chain, the researchers developed a food chain traceability system based on Blockchain technology. They implemented this system using Ethereum Blockchain technology. This food tracking system is decentralized in nature and protects sensitive business data through smart contracts. This system provides a secure environment for the food supply chain, ensuring data security, preventing spam attacks and system resilience, without the risk of data alteration. Perishable foods are sensitive to environmental conditions, so tracking and tracing them at every stage of the supply chain is essential. The researchers used Blockchain technology to create an anti-counterfeit food packaging database to track and monitor the quality of scanned food packaging in retailers, logistics and warehouses. All real-time sensor data from each scanned food package is updated on the Blockchain, providing a digital anti-adult food package history. The researchers proposed a system to improve food safety in the food chain using IoT and Blockchain technology.

The proposed system uses a QR code that stores all food-related information, including the date of manufacture and expiration date. Blockchain technology prevents the importation and entry of counterfeit or illegal food so that customers can obtain authentic food. Spoilage of perishable foods is a common problem. The current SCM system does not provide any mechanism to control the quality of perishable food. researchers worked on perishable food supply chain traceability by implementing a viable solution based on Internet of Things and Blockchain.

Each shipment of perishable food is equipped with IoT sensors and the quality is recorded using a distributed ledger and smart contract technology and shared among all stakeholders. Current agricultural and food supply chains based on IoT technology are centralized and have a single point of failure. The traceability of crops and food is difficult and there is no communication channel between farmers and buyers. These IoT-based agricultural and food chains are not energy efficient. To solve all these problems, the researchers proposed a comprehensive solution for agri-food supply chains based on blockchain and IoT. Farmers can use the Internet of Things to obtain information about yield, soil temperature and soil quality to improve crop production. Crop growth can be monitored and recorded.

Blockchain helps manage real-time food safety status updates to all stakeholders in a decentralized manner. The researchers also proposed an efficient low-energy clustering protocol for the agri-food supply chain to extend network lifetime and reduce energy consumption. The researchers also

proposed a blockchain and IoT-based tracking system for agri-food supply chains to provide consumers with a transparent view of the entire food journey from farm to table. And the inspection team can monitor the food quality and work practices online. The researchers developed a blockchain and IoT-based system based on a distributed ledger and smart contracts for product traceability. In this system, the entire process, ie. product registration, transfer and tracking is done with the help of smart contracts.

One of the problems with traditional product tracking systems is the "Man-in-the-Middle" attack. The researchers also introduced a transaction response mechanism where the signature generated for a transaction is verified to ensure the identity of both parties to the transaction to prevent a Man-in-the-Middle attack. The researchers used Blockchain to monitor the quality of service of industrial IoT-based applications. The researchers discuss the use case of transporting furniture. Quality of service is measured by comparing the expected performance of the application with the actual performance.

The researchers proposed a Blockchain and IoT-based solution to prove the authenticity of 3D-printed products, which enables trust between stakeholders involved in the additive manufacturing process. The researchers used an Ethereum-based smart contract to track customer-initiated events in the production process. The researchers used Blockchain and IoT to produce medical devices and accessories. The researchers reflect on the COVID-19 pandemic, during which the use of a traditional SCM system for medical devices and supplies was difficult because the traditional SCM system lacked robust traceability.

The researchers developed Blockchain, an IoT-based solution implemented with Ethereum smart contracts for the digital production of medical devices and supplies. It makes the entire digital production process transparent, reliable, secure, auditable and traceable. The researchers developed a mobile application for a pharmacy. Creators are digitizing the process of buying medicines by implementing solutions based on IoT and blockchain, where consumers can verify the authenticity of the medicine they buy by scanning the QR code associated with each medicine to avoid buying a fake medicine. IoT and Blockchain can also be used in medicine to monitor real-time temperature conditions.

This mobile application is implemented on the NEM Blockchain. The researchers also facilitate the purchase of drugs with cryptocurrency. The researchers also contributed to the medical supply chain by applying blockchain and IoT-based “crypto-loading” for smart delivery of vaccines. The "Cryptocargo" implementation is also based on the Ethereum blockchain. With this proposed new transport solution, the temperature, humidity, lightness and coating state of the vaccines inside the cargo can be monitored in real time, allowing to track and fix violations through smart contracts using Blockchain.

The researchers developed an SCM trust model using IoT and Blockchain, so that all data produced by IoT devices and events during the supply chain process are recorded using Blockchain technology. It creates trust among all stakeholders because tracking, monitoring and managing products becomes easy and does not require a trusted intermediary. Used vehicles are purchased from a third party and the buyer does not know authentic information about the vehicle, such as its

battery life, performance and charging. To solve this old EV supply chain problem, the researchers introduced IoT and blockchain solutions. The researchers used the Ethereum blockchain for implementation purposes.

Buyers and sellers using this system can directly transmit all information about electric vehicles such as production, delivery information, owner information, battery information, maintenance reports, police reports, accidents, etc., and it is transparently shared with the buyer. The researchers also introduced cryptocurrency payments to improve and facilitate the EV ecosystem. The researchers conducted simulations of traditional order management scenarios as well as blockchain and IoT-based scenarios to observe the performance of both order management. The researchers found that scenarios based on Blockchain and IoT offered better performance in order management, enabling transaction transparency, easy sharing of information through RFID, collaboration between stakeholders and product traceability using Blockchain technology.

Agile supply chains are based on a "sense and react" mechanism. The researchers presented a framework for modern flexible supply chains with IoT technology to quickly identify and react during the supply chain process, and Blockchain technology to ensure trust and security in flexible supply chains.

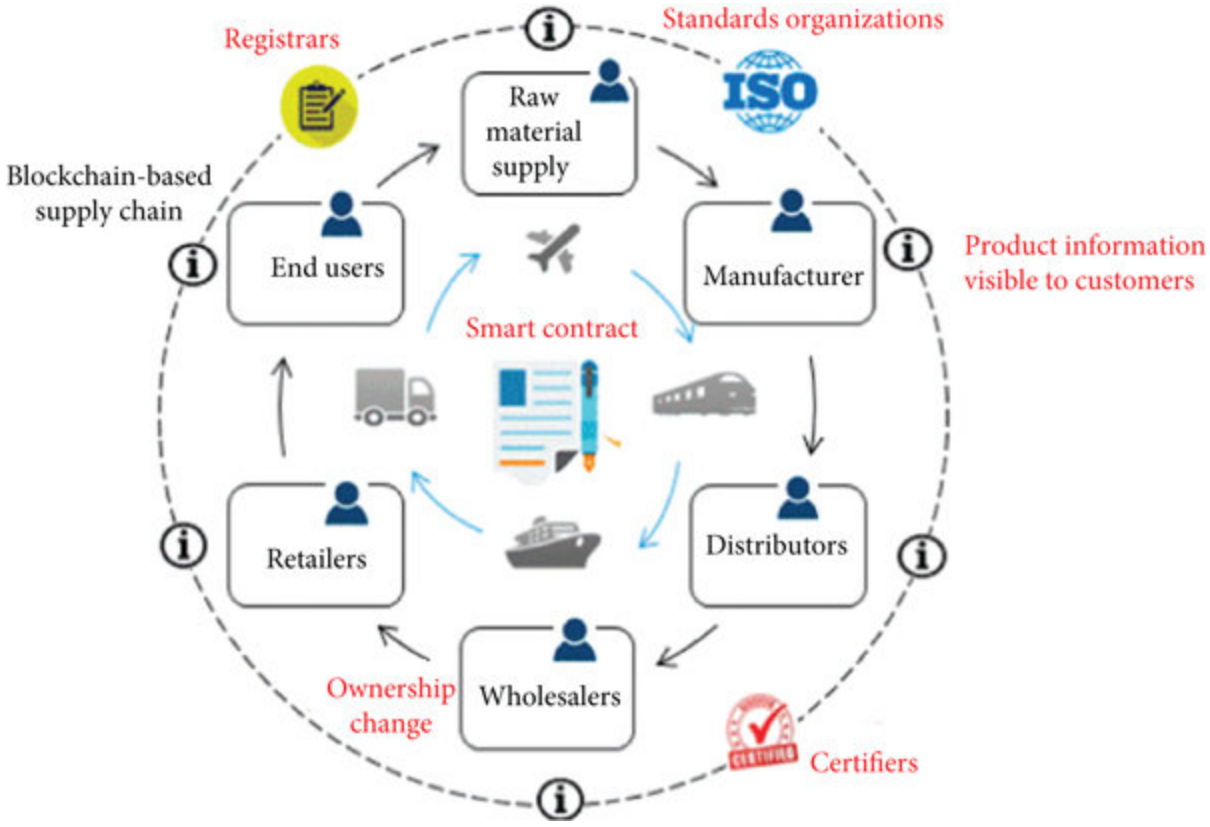

Figure 6

3. Cloud Computing IoT-based SCM

Cloud computing IoT-based SCM can become more reliable by using cloud solutions to manage storage-related data or process sensor data through cloud computing. The researchers used a centralized cloud database to store dynamic data collected from Cloud Supply Chain sensors and static data collected during real cold supply chain operations. The researchers proposed a reference architecture for IoT-based logistics information systems in agri-food supply chains.

The researchers presented an intelligent logistics cloud system that provides storage and processing for various scenarios such as transaction management, product labeling and registration; recall of product in case of food failure; and quality prediction based on data collected by sensors.

The researchers also used cloud computing for food tracking. The cloud provided real-time performance monitoring, database management, constant data replication, and account permissions. The researchers used the FIWARE cloud platform to develop their system to improve the overall logistics process, including data sharing and processing. The researchers proposed a mobile application-based system for monitoring the condition of perishable foods. The researchers used the cloud to store data from sensors installed in nearby food stores. Users can check the status of perishable food in real time using the mobile app. The researchers used cloud storage for their smart vaccine delivery system called cryptocargo based on IoT, blockchain and cloud. The cloud server stores vaccine tracking data.

The researchers also created a mobile application "DAapp" that provides 24/7 access to tracking data stored in the cloud and Blockchain. The researchers used Blockchain cloud storage in the used electric vehicle supply chain to track the performance of electric vehicles. The researchers used cloud storage in their mobile application to meet the needs of the medical supply chain. The researchers used cloud computing to develop collaborative management and information sharing platforms for supply chain inventory management.

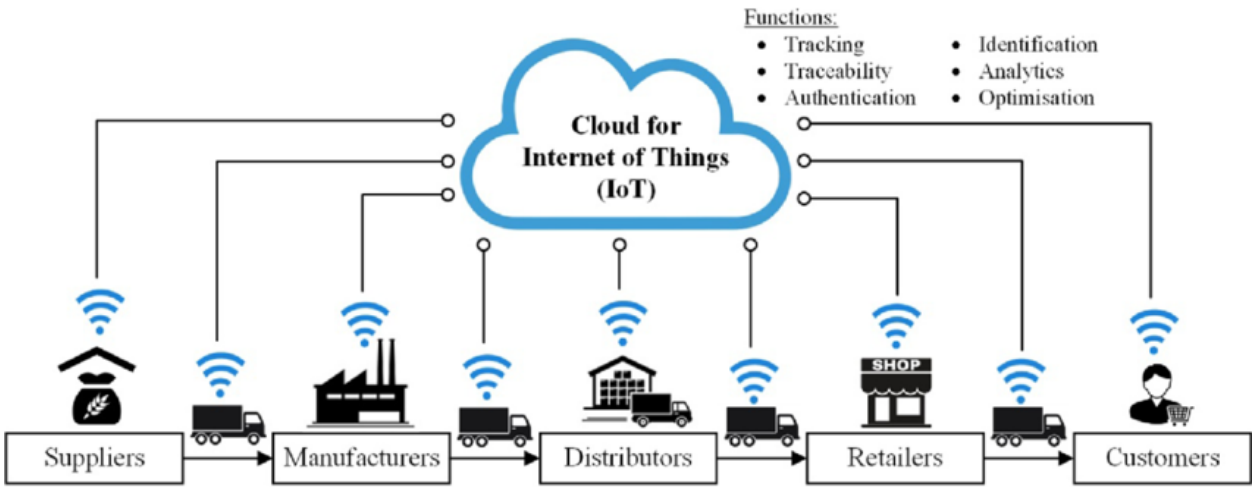

Figure 7

4. Near field communication

NFC stands for Near Field Communication. NFC technology is used to wirelessly share data between nearby devices. Modern SCM uses NFC for various tasks such as asset tracking and product traceability. The researchers used NFC tags to track assets in an asset supply chain. The researchers developed a mobile application for asset tracking and management. The researchers used an NFC tag for food traceability. Food packages were placed with NFC tags for tracking.

Figure 8

5. Distributed Ledger Technology

Researchers of smart tags contributed to the development of verifiable SCM by implementing a Blockchain solution. The researchers used Ethereum Blockchain technology and distributed ledger technology, which is the backbone of Blockchain, to create a smart tag "DL-Tag" to manage a decentralized, privacy preserving and verifiable product tag. The customer and all shareholders can verify the authenticity of the product. This innovative Tag solution prevents customers from buying fake products that are sold as genuine products.

Figure 9

6. Quick Response Code

QR code A QR code, or "quick response code", is a two-dimensional bar code that stores information. QR codes are square and contain a series of dots that store information. Modern SCM uses advanced QR codes that are more durable. The researchers used a QR code generated by Ethereum, which was used in the inspection of used electric vehicles.

A QR code generated by Ethereum can never be tampered with because it is linked to an address on the Ethereum blockchain. This uniqueness creates trust among all shareholders. The researchers introduced this QR code generated by Ethereum into the supply chain of used electric vehicles. Whenever a person wants to buy a used electric car, they get all the information, history, details and performance of the vehicle through a QR code generated by Ethereum.

The researchers also used a QR code based on the NEM Blockchain in the medical supply chain to obtain medical information, including information about its manufacturer, price, tracking information, manufacturing date, and expiration date. Any customer or interested group can check the medicine by scanning the QR code with the mobile application.

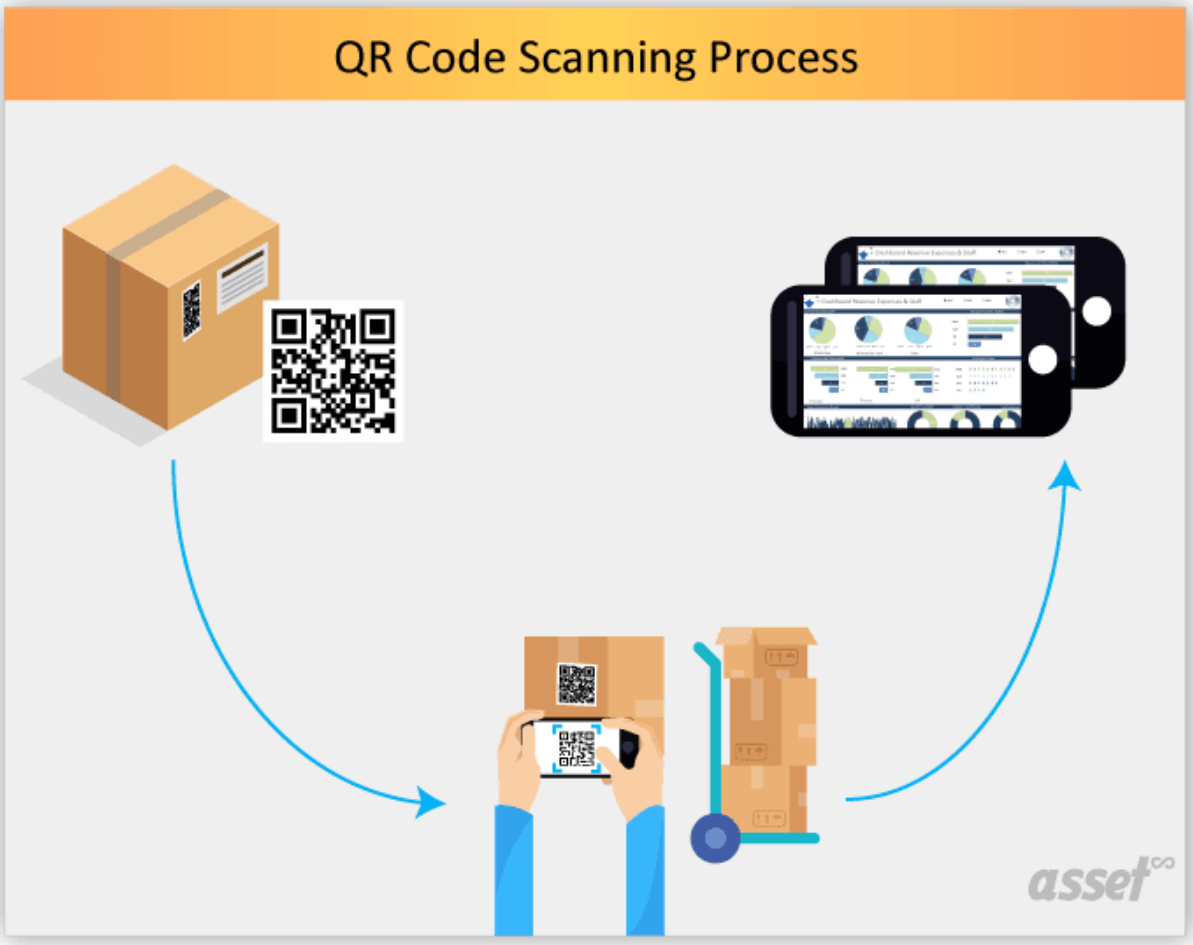

Figure 10

7. RFID

RFID researchers used RFID to track products; An RFID tag is attached to each product and scanned with an RFID reader. After scanning the products, all the information related to the product, such as its manufacture, expiration date and warranty period, are stored on the website, where suppliers and managers can get all the information about the products. The use of RFID makes the supply chain process transparent. Researchers designed an IoT-based food safety monitoring and traceability system where RFID is used at every stage of the supply chain.

Food information is collected from raw material companies, manufacturers, logistics vendors and vendors with RFID tags. In terms of food safety and traceability, it helped trace the entire food chain process from farm to table. If food-related incidents occur, the inspection department can easily check it, because information about all the food is added to the food information database. researchers used RFID for inspection and identification of agricultural products. The researchers used RFID technology to identify returned products in the reverse supply chain. RFID is also used

for inventory management such as product storage, movement, inventory management, product assembly and distribution.

The researchers used RFID technology to track financial risk management commitments in supply chains. The researchers integrated Blockchain with RFID to create a transparent and secure food supply chain. The researchers used RFID in the physical layer and Blockchain in the cyber layer. When food packages are scanned with RFID in food packaging, logistics, warehouse and supply chain at the retailer, real-time data related to RFID food packages is updated on the blockchain, providing an anti-counterfeit digital history. of food packaging. . The researchers used RFID in the supply chain of school uniforms. The researchers emphasized the integration of the use of RFID in every link of the supply chain.

RFID is used in manufacturing, warehousing, distribution and sales links to ensure that all stakeholders, including customers and managers, receive the correct product information. The researchers used RFID technology in the healthcare supply chain. The researchers used RFID technology to authenticate drugs and medicines in the medical supply chain; the researchers considered the case of COVID-19 kits and implemented RFID into the COVID-19 kit to protect patients from counterfeit drugs. It also worked in brand protection and logistics management.

The researchers proposed a trust model for information sharing in SCM. The researchers suggested the use of RFID to store product information because this technology is a fast response technique and is suitable for creating trust between shareholders when sharing information about products. The researchers used RFID to develop an intelligent product shelf that utilizes the RFID identification information of products to provide customers with real-time inventory and hot-selling products. This service also helped warehouse management to immediately replenish hot selling products according to customer needs.

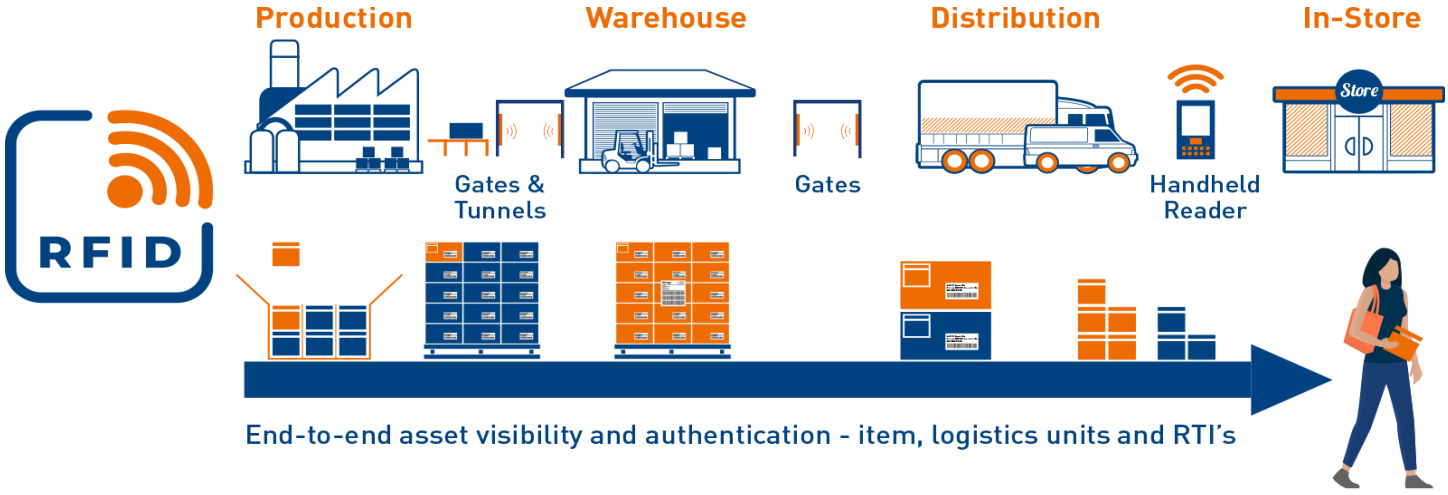

Figure 11

The sensor used for IoT-based SCM

In IoT-based SCM, sensors play an important role in collecting various data. Sensors help track and trace products. Below figure shows the list of sensors in IoT-based SCM literature. This section discusses the sensors used in the review studies and analyzes in which SCM application areas these sensors were used. Below figure clearly shows the SCM sensors and the application areas where these sensors were used.

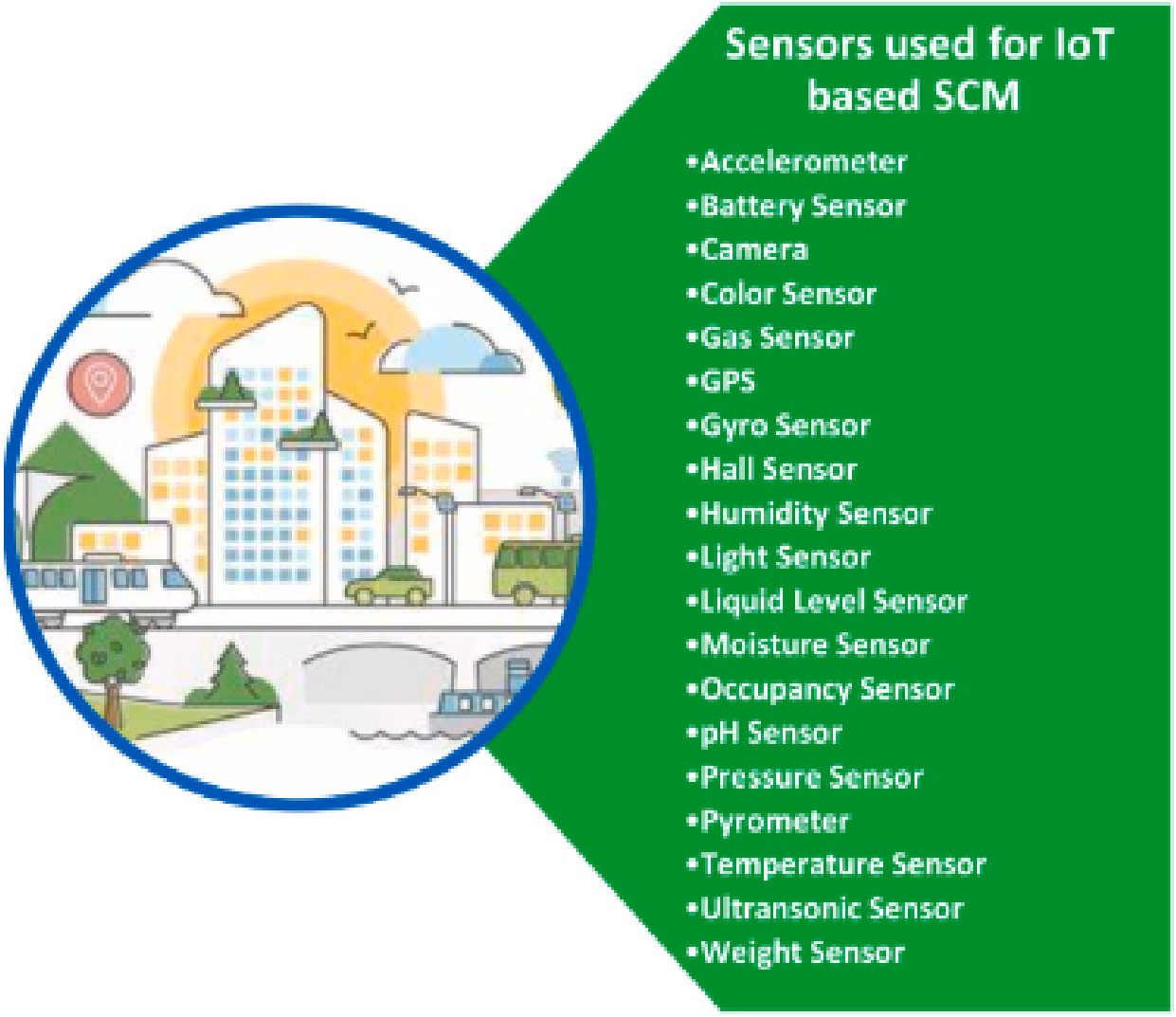

Figure 12

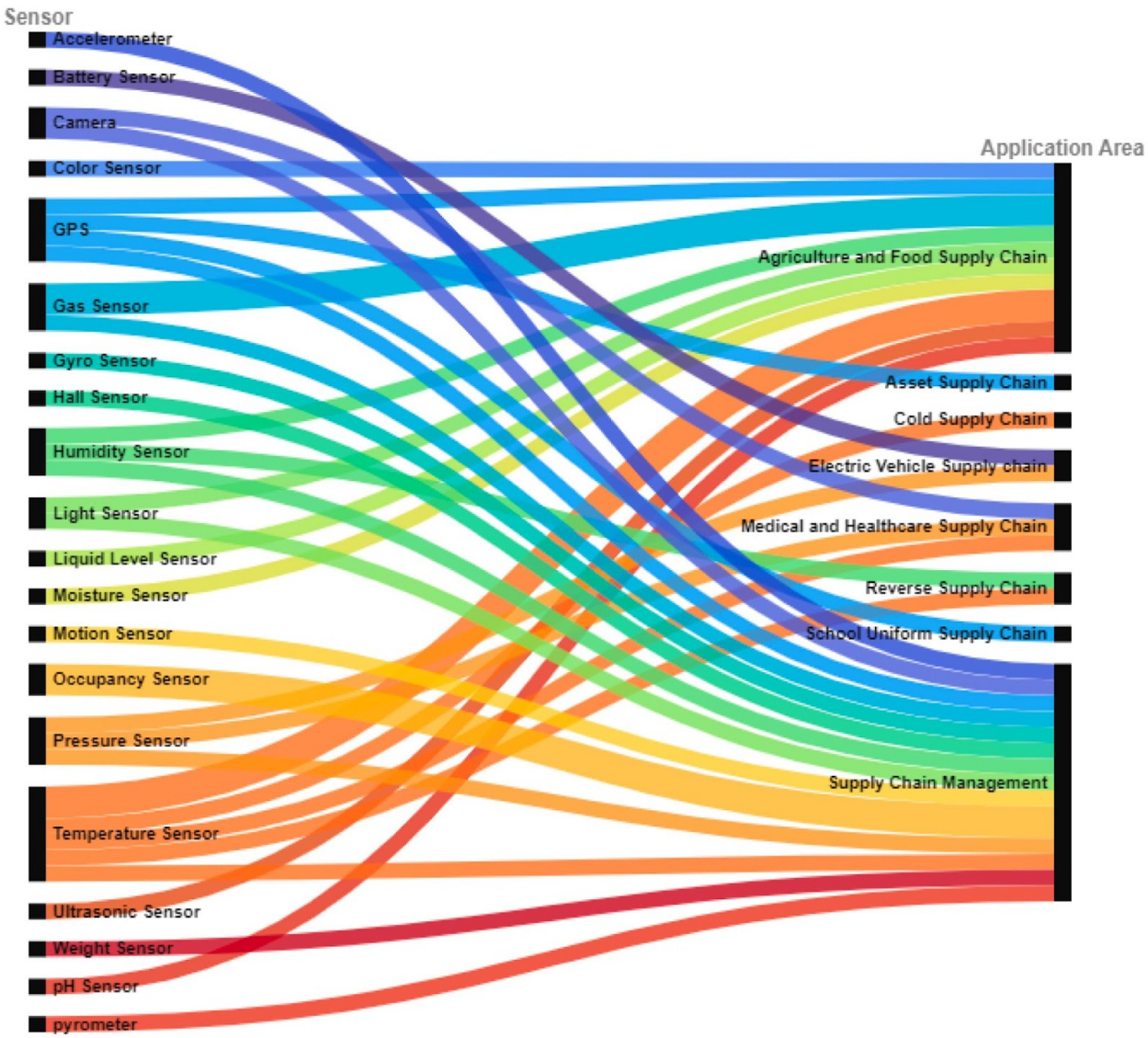

Figure 13

1. Accelerometer:

An accelerometer is a sensor that measures acceleration or vibration and is widely used in shipments or containers. The accelerometer monitors the mechanical shocks, impacts and movements that the container experiences. researchers used an accelerometer to measure vehicle acceleration or speed.

Figure 14

2. Battery Sensor:

Battery heat and charging time sensors are used in electric vehicles to monitor their performance.

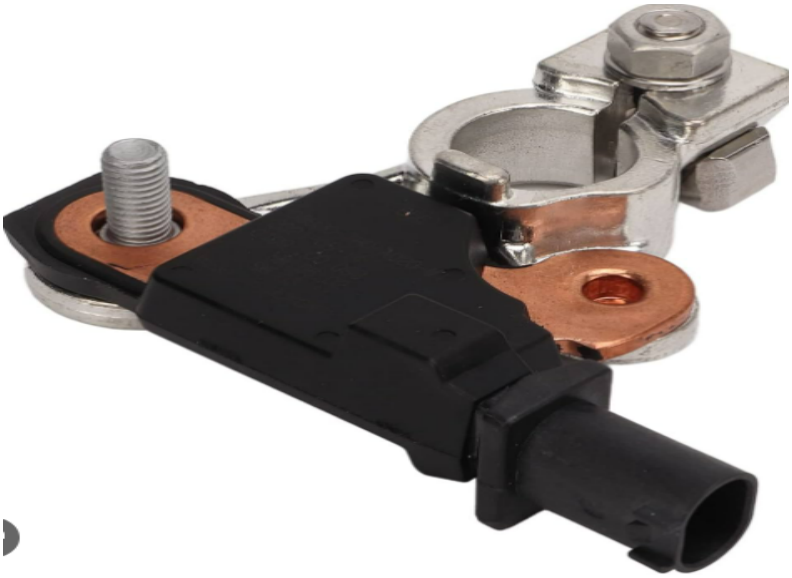

Figure 15

3. Camera Sensor

A camera sensor is used to identify products. The researchers used camera sensors in additive manufacturing to record the 3D printing process. The researchers used a camera to monitor the deposits. The researchers observed the production process of medical and health supplies with a camera.

Figure 16

4. Color Sensor

A color sensor, also known as a photoelectric sensor, is used to detect the color of objects. The researchers used color sensors to monitor perishable foods, and the researchers used this sensor to monitor the freshness of vegetables.

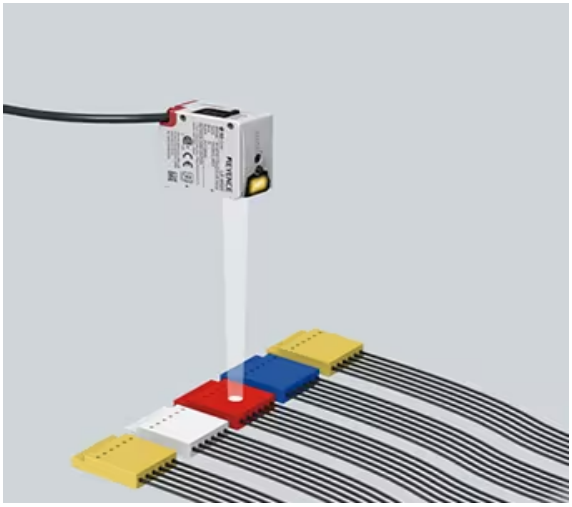

Figure 17

5. Gas Sensor

Researchers used GPS for outdoor tracking of logistics vehicles to ensure product safety on board. The researchers used GPS sensors to track and trace assets in the asset supply chain. The researchers used GPS sensors in transport systems for agricultural products. The researchers used GPS sensors for vehicle tracking in transportation and distribution systems. A GPS sensor is used to monitor and control financial obligations.

Figure 18

6. GPS

A gyro sensor is used to detect direction. The researchers used gyro and GPS sensors for vehicle tracking in transport and distribution systems.

Figure 19

7. Gyro Sensor

Hall sensors detect the presence and magnitude of a magnetic field using the Hall effect. The researchers used halo sensors in warehouse management to detect the attachment/removal of warehouse tags.

Figure 20

8. Humidity Sensor

A humidity sensor is used to measure the amount of water vapor. The researchers used humidity sensors in intelligent transport systems for product distribution. The researchers used moisture sensors to monitor transport conditions in the agri-food supply chain. The researchers used humidity sensors in a smart container used in a reverse supply chain. The researchers used humidity sensors to detect humidity in the warehouse.

The researchers used humidity sensors to measure food moisture in a storage area for near-perishable food. The researchers used humidity sensors to measure the humidity of medical supplies. The researchers used humidity sensors to measure the temperature of the agricultural environment. The researchers used humidity sensors in agriculture and food chains to measure humidity in food storage areas. The researchers used humidity sensors to measure the environmental parameters of logistics.

Figure 21

9. Light Sensor

A light sensor is used to detect light intensity. The researchers monitored the theft of shipments and the dangers associated with manipulation using light sensors in the container. The researchers used light sensors to detect light changes and monitor the freshness of perishable foods in a closed warehouse. The researchers used a light exposure sensor to detect the opening of the container. The researchers used light sensors to monitor crop growth. The researchers used light sensors for skill input. The researchers used light sensors to monitor the product.

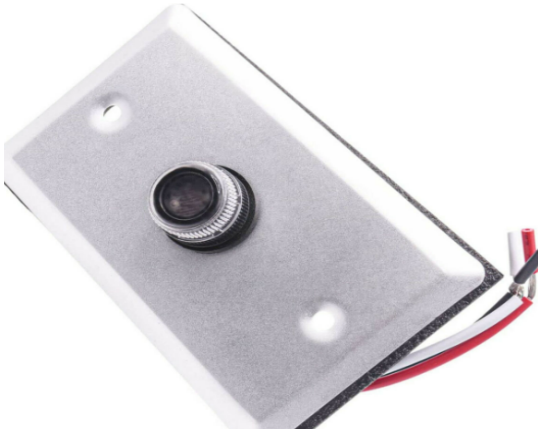

Figure 22

10. Liquid Level Sensor

A liquid level sensor measures the liquid level by measuring the height of the liquid. The researchers used liquid level sensors in crop growth monitoring to measure the amount of water used according to crop growth.

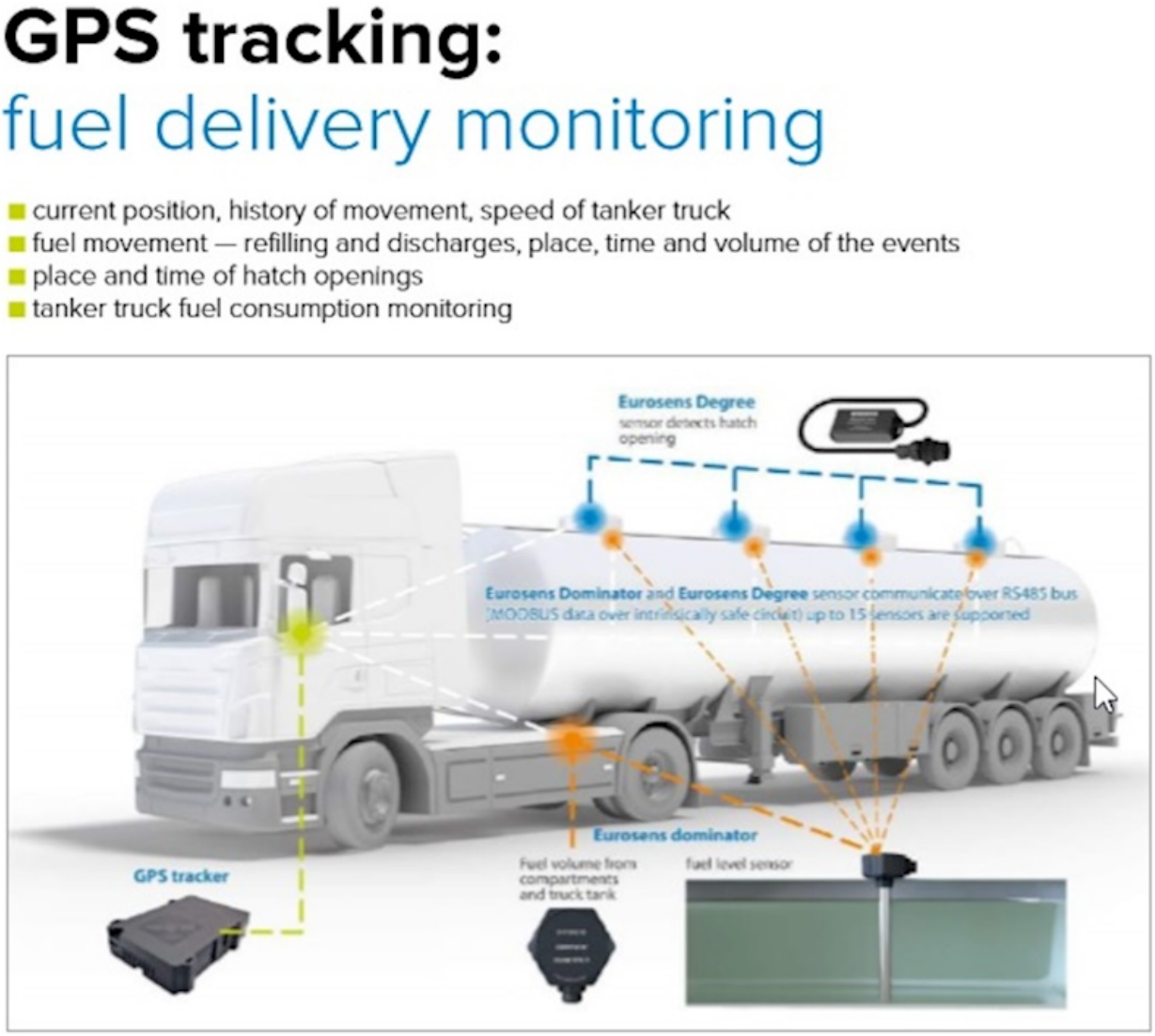

Figure 23

11. Moisture Sensor

A moisture sensor detects the amount of moisture or water in a material sample. The researchers used moisture sensors to monitor crop growth in agriculture and the food chain by detecting soil water content.

12. Motion Sensor

A motion sensor is used to track moving objects. The researchers of the book [23] used motion sensors in transport and distribution systems to monitor the spread of transport vehicles from certain routes.

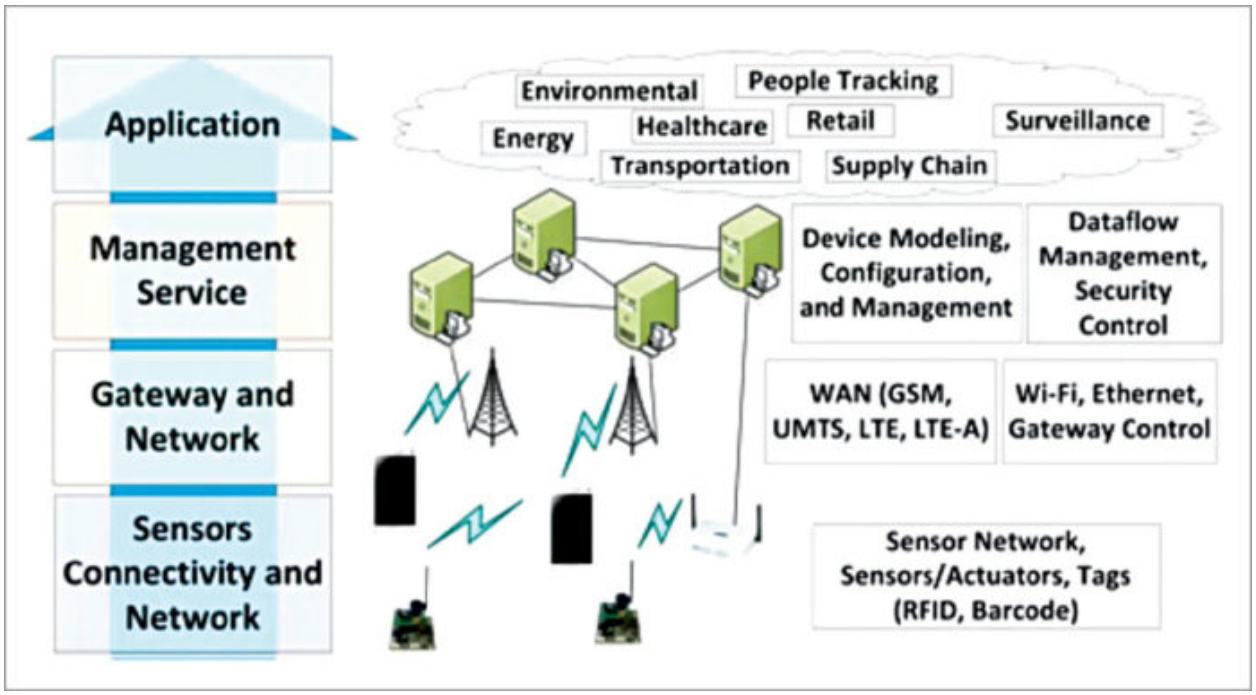

Figure 24

13. Occupancy Sensor

A presence sensor is used to detect the presence of people or living objects such as animals in an area. The researchers used presence and door sensors in a shipping container to monitor the risks of theft and manipulation in shipping. A presence sensor helped monitor the presence of an outsider, and a door sensor triggered an alarm when the shipping door was opened without permission due to theft or tampering.

14. pH Sensor

A pH sensor measures the acidity or alkalinity of a liquid or water. The researchers used pH sensors to measure the pH level of water used by crops in agriculture and the food chain.

15. Pressure Sensor

A pressure sensor is used to measure the pressure of gases and liquids. The researchers used pressure sensors for the production of medical supplies. The pressure sensor is also used to monitor the tire pressure of the vehicle from the point of view of intelligent transportation. The researchers also used pressure sensors to measure the tire pressures of an electric car.

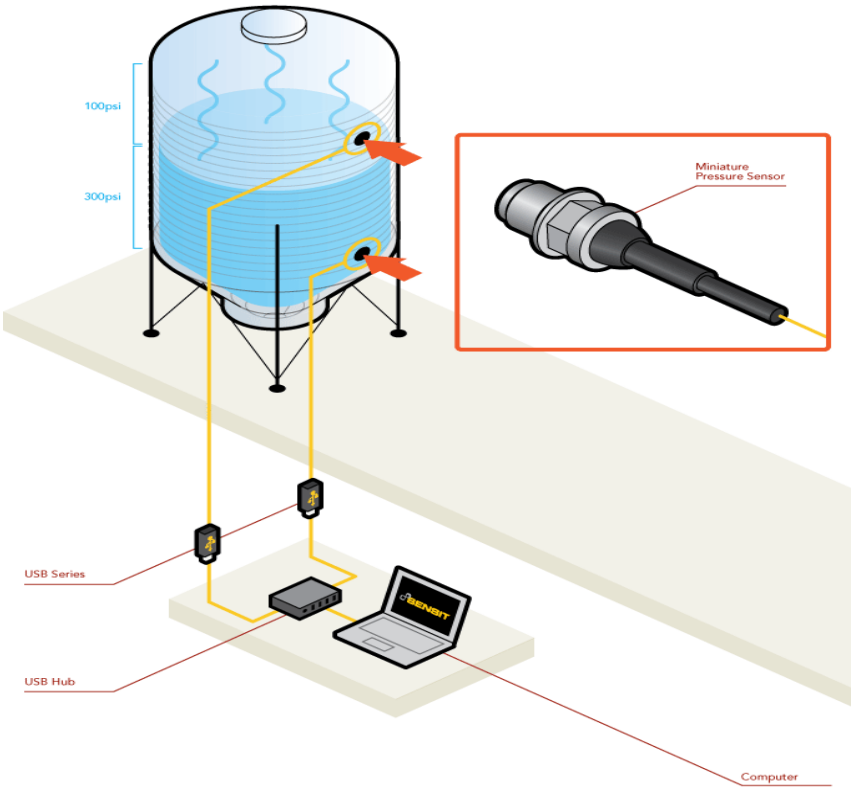

Figure 25

16. Pyrometer

A pyrometer measures high temperature levels by measuring the thermal radiation of an object. The researchers measured the engine and wheel axle temperatures of a logistics vehicle with a pyrometer.

Figure 26

17. Temperature Sensor

The temperature sensor measures the degree of heat or cold of the object. Researchers used temperature sensors in intelligent transport systems for product distribution. The researchers used temperature sensors for their intelligent agri-food logistics environment. The researchers used a temperature sensor in a smart tank for a reverse supply chain. The researchers used temperature sensors in cold food supply chains because it is necessary to maintain the temperature in cold food supply chains. The researchers of publications used temperature sensors in the warehouse to monitor the ambient temperature.

The researchers used temperature sensors for perishable foods in closed warehouses to maintain the freshness of perishable foods. researchers used temperature sensors to maintain the temperature of medical supplies and temperature-sensitive shipments such as vaccines. The researchers used temperature sensors to measure the temperature of the agricultural environment. The researchers used temperature sensors to measure the temperature of food in agriculture and food chains.

Temperature sensors are not limited to the above application areas of SCM. It is also used to measure soil temperature to monitor crop growth. The researchers used temperature sensors to monitor crop growth in agriculture and the food chain. The temperature sensor is also used to measure the temperature of nutrient solutions in hydroponic farms in smart cultivation and irrigation systems. Temperature sensors are also used to monitor a certain temperature level. The researchers used a thermo-temperature sensor to monitor conditions in a shipping container.

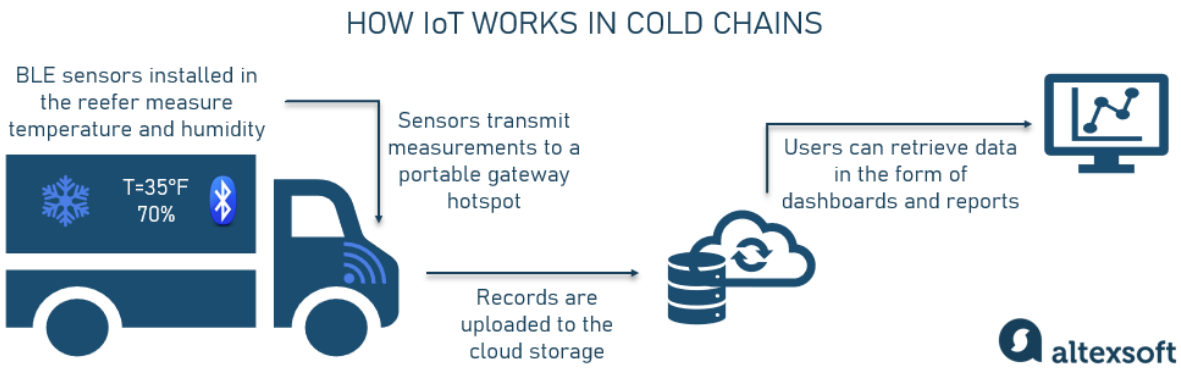

Figure 27

18. Ultrasonic Sensor

An ultrasonic sensor is used to measure the distance of an object using ultrasonic waves. The researchers used ultrasonic sensors to measure the water level.

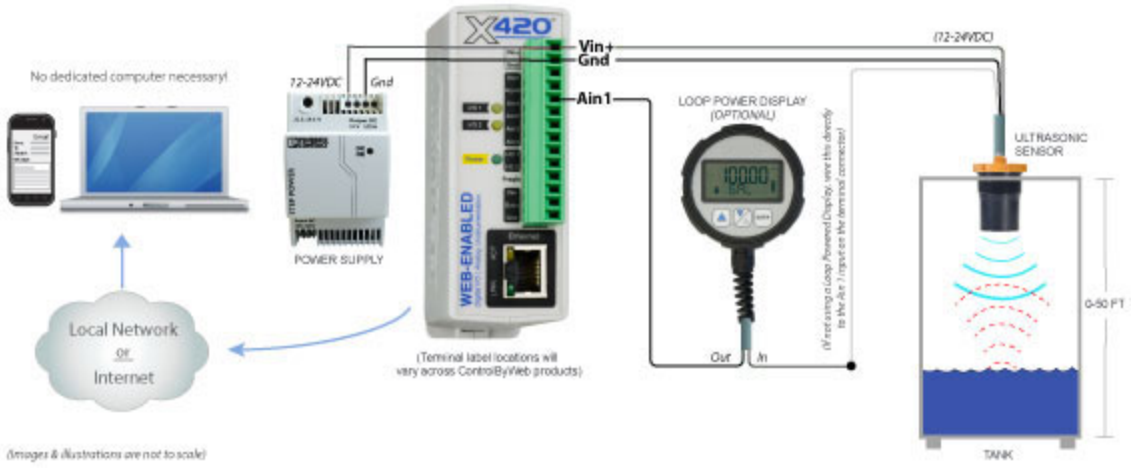

Figure 28

19. Weight Sensor

A weight sensor is used to measure the weight of objects as it is connected to a weight scale. researchers used weight sensors in warehousing.

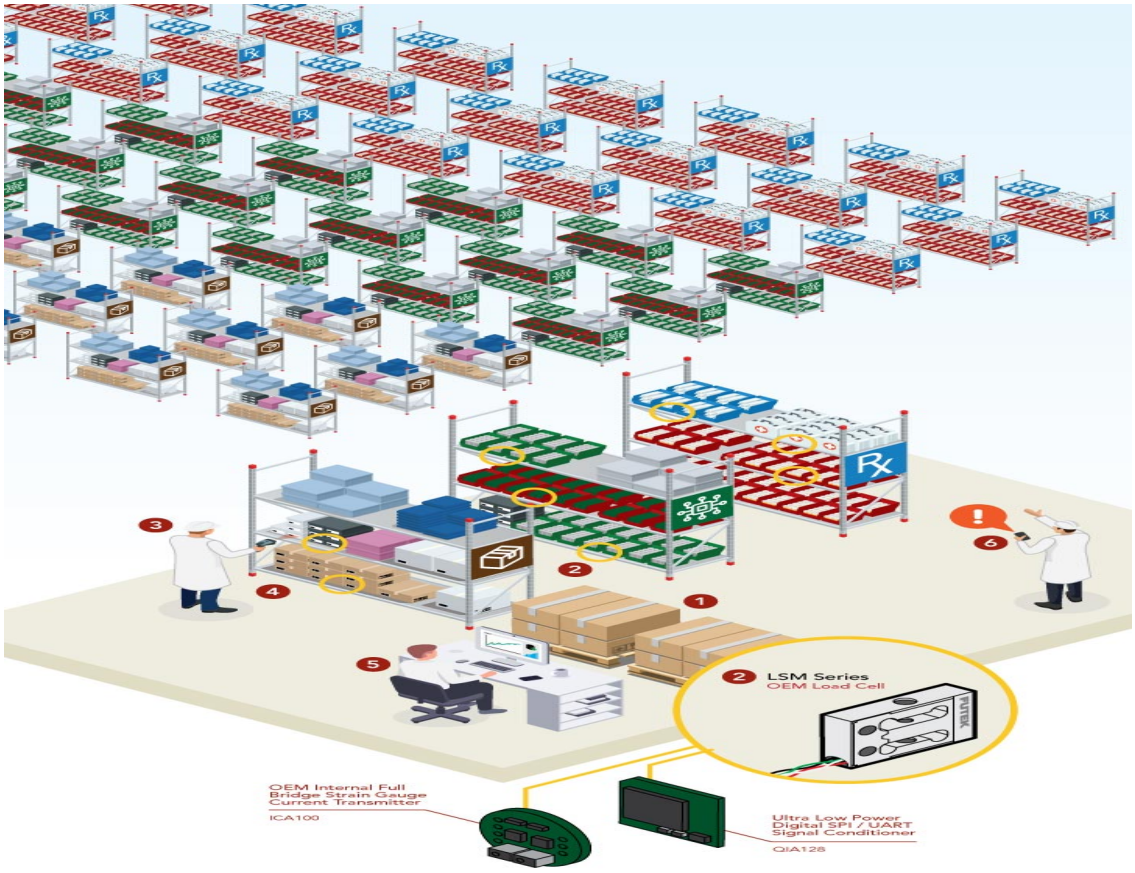

Figure 29

IoT based SCM challenges

Consumer demand for products with complex designs Due to factors such as changing consumers, taste and technological development, the demand for products varies. As a result, the company faces challenges in terms of product demand and supply. Therefore, it is difficult to predict the demand for products.

Advanced technologies in artificial intelligence, machine learning, and deep learning can be used to overcome these limitations and challenges to anticipate consumer demand in IoT-based supply chain management. The researchers used historical delay data to predict demand for specific products. The pan whip phenomenon is also considered one of the most complex phenomena in SCM. This phenomenon describes instability and variability in orders of products and suppliers at different points in the supply chain, caused by a lack of communication and coordination between different stages of the supply chain. This leads to common or rare accessories. This causes inventory or delay situations or forces companies to lower prices.

The researchers proposed a solution based on cloud and 5G Internet technology for a collaborative storage management and information sharing system. The researchers addressed product shortages using artificial intelligence and RFID technology. The researchers developed

an intelligent agent-based forecasting system that shows product recommendations to customers based on real-time information from product shelves and recommends customers' products for hot sales. It also notifies sales support of out-of-stock products to help them restock.

Cybersecurity Risks Associated with IoT-based supply chains IoT-based supply chains use a combination of physical and digital systems. This raises the level of cyber security risks. Organizational system vulnerabilities and machine-level vulnerabilities are expected for multiple connected devices and machines in a single IoT network. This is because the IoT infrastructure is not integrated according to global standards and data protocols.

High investment costs for building IoT infrastructure in SCM One of the biggest obstacles in moving from traditional SCM to an IoT-based infrastructure is the high investment costs. When building an IoT-based SCM infrastructure, companies must deploy the necessary resources, network devices, sensors, and skilled workers. All these things require large investment costs, which can be expensive for small businesses.

Network gaps The network infrastructure for IoT-based SCM is not yet widespread. Since SCM processes are geographically dispersed and require continuous data flow and real-time traceability, this is one of the challenges of IoT-based SCM. These requirements can only be met with a highly efficient network infrastructure. Because 4G networks offer low latency and high-speed data transmission over the Internet, they are useful for IoT-based SCM. This can be further improved with 5G networks as they offer very low latency and are faster for real-time data transfer, which is essential for SCM processes. Researchers launched a Supply Chain Inventory Collaborative Management and Information Sharing system that uses RFID, cloud and 5G Internet technologies to share real-time information about products in different stages of the supply chain between stakeholders.

CHAPTER 5 : Conclusion

Traditional SCM suffered from many problems, including less transparent supply chain processes and difficulties in real-time tracking of goods. This also includes things like counterfeit products resulting from a lack of transparency in the supply chain process. IoT-based SCM is an emerging practice to modernize the traditional SCM process using IoT.

Modern SCM is more transparent because there are no issues with product tracking. It is also easy to store products from raw material sourcing, manufacturing and distribution. A gap was found in the literature that there was no comprehensive SLR. This paper presented the first IoT-based SCM SCM by analyzing the literature of the past five years in detail. This study contributes to the knowledge of IoT-based SCM by covering key areas of the subject such as application areas, technologies, sensors and devices used to implement such systems.

The SLR findings are exciting and valuable, and can help future researchers quickly evaluate SCM-based IoT. This review reveals that in addition to IoT, IoT-based technologies such as artificial intelligence, blockchain, and cloud computing have recently been adopted in the field and can be further explored to improve IoT-based SCM.

This overview also gives a clear picture of the fields of application. Most of the research is done in the agri-food supply chain, and little work has been done in the medical and health care supply chain, industrial and manufacturing chain. Industrial and production chains can be further explored when future researchers focus on Industry 4.0 and Industry 5.0, so it would be a good application area for IoT-based SCM. Companies are also focusing even more on sourcing and delivering goods and services in ways that reduce their negative impact on the environment, society and economy.

In light of the above, the idea of sustainable supply chain management (SSCM) has attracted interest in business and academia, as it emphasizes corporate responsibility from an environmental, social and economic perspective.

Business implications of implementing IoT-based SCM

Using sensors, devices and smart tags, companies can obtain real-time information about various supply chain processes, such as inventory levels, equipment performance, temperature conditions and energy usage. Thanks to IoT, it is now easy for companies to track shipments, which helps companies fulfill orders on time. It also promotes transparency in supply chain operations, which helps companies better manage inventory and inventory management. Businesses enabled by IoT can now deliver a personalized customer experience to their customers. By embedding IoT devices, sensors, and smart apps into their products, companies can gain useful information about customer usage habits and preferences. This enables customized product offerings, targeted marketing initiatives and a better customer experience.

The overall customer experience can be further enhanced with IoT-enabled devices that provide customers with real-time monitoring and remote control capabilities. IoT also helps in preventive maintenance and asset management. Companies can monitor performance, detect anomalies and identify maintenance needs by collecting data from IoT sensors embedded in assets and machines. Businesses can proactively avoid unexpected downtime. It also reduces repair time and cost and extends the useful life of the asset.

IoT enables remote monitoring so organizations can manage and optimize their assets across multiple locations.

CHAPTER 6 : Suggestions and Recommendations :

Benefits of IoT based SCM

Using IoT, Sustainable Supply Chain Management (SSCM). Traditional approaches to supply chain management have focused primarily on the efficiency, affordability and simplicity of supply chain operations. In 2008 the concept of sustainable supply chain (SSCM). These researchers argue that SSCM integrates the economic, environmental and social aspects of sustainability.

The use of IoT in the SCM process promotes sustainability and enables the production of high-quality products with economical and environmentally friendly technologies. In addition to economic and environmental aspects, SSCM is defined in terms of social aspects, as it is based on a tripartite approach involving people, planet and profit. According to the framework, achieving sustainability in the supply chain process is based on three main factors, viz. economic, environmental and social. By considering these factors in IoT-based SCM, organizations can achieve sustainability.

Economic factors include long-term financial and non-financial perspectives. Financial perspectives include supply chain activities such as purchasing, inventory and transportation, while non-financial perspectives include activities such as market growth, inventory and warehouse management, and transportation and distribution. Organizations should consider green practices from both financial and non-financial perspectives to achieve financial sustainability. Environmental factors include activities that must be considered, such as material consumption, energy, waste and pollution.

Organizations must ensure sustainable operations to achieve environmental sustainability by producing products using the least amount of resources, using energy efficiently, and reducing pollution by properly disposing of waste so that IoT-based SCM activities are environmentally friendly. To achieve social sustainability, it is also important to consider social factors. This includes aspects that may be internal to the organization, such as employee and customer rights, which must be maintained. External factors include community and social services. In supply chain operations and product design, organizations must consider its impact on the production of healthy and vibrant communities. Thus, organizations also achieve social sustainability. Considering all three factors creates an IoT-based SSCM.

Better transport capacity, recycling and reuse of packaging, lower consumption of resources (water and energy) and compliance with environmental regulations, for example SSCM's green practices. From raw material sourcing (green procurement) to manufacturing (eco-friendly design), retail and distribution can drive the adoption of SSCM. The researcher used Blockchain technology and IoT and RFID technologies to track products, which helped to achieve environmental sustainability by monitoring product temperature or environmental conditions in real time, especially for the food chain. food safety issues, which may include food spoilage or foodborne illness.

This study also helped identify adulterated food as a threat to public health. Thanks to social sustainability, the transparency of the system allows products to be traced from the place of origin to the final consumer. Trust is the most important condition for social sustainability.

A transparent supply chain creates trust between business customers, which helps achieve social sustainability. In summary, the proposed system provided the means for fast delivery of products and real-time monitoring of supply chain activities, shortening process control.-Reducing environmental risks IoT helps achieve sustainability by reducing environmental risks. Environmental issues and climate change can affect the supply chain management process. Intelligent supply chain management processes are based on the Internet of Things, and other IoT-enabling technologies such as artificial intelligence help to reduce these environmental risks. Automated drones can be used to monitor traffic during product distribution, and other IoT sensors can be used to monitor environmental pollution throughout the supply chain process. One study identified in a systematic review presented an innovative solution for monitoring occupational safety risks in cold supply chains, as inadequate risk assessment and management can lead to cold-related accidents, injuries and even death.

The researchers proposed to create an IoT-based environment in cold supply chains to better monitor workers working in demanding conditions in real time using IoT sensors. Cold chain workers had to wear Microsoft tapes that allowed them to monitor their physical health. Other important sensors were also used to collect real-time information about the temperatures of the various cold supply chains. IoTRMS, a web-based tool, was developed to monitor occupational safety issues.

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