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Review

Traceability of Sustainable and Safe Fisheries Supply Chain Management Systems using Radio Frequency Identification Technology

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Abstract: At present, sustainability and emerging technology are the most expressed issues in any supply chain management (SCM) sector. At the same time, pandemic makes consumers more concerned regarding health, and safe food with a sustainable way to access the current market. Thus, supervision and monitoring of product quality with symmetric traceability information in fresh food and fisheries SCM is significant. Research on food safety and traceability systems based on blockchain, internet of service (IoT), wireless sensor networks (WSN), and radio frequency identification (RFID) provides the solution of constancy from production to consumption. This review focused on the RFID-based traceability systems in fisheries SCM, which have been employed globally in the last fifteen years to ensure fish quality and security. Additionally, a summarized comparison study has presented different sectors' traceability systems using RFID and their advantages over real-time applications. The outcome of this study will help future researchers to solve the crisis in terms of trust between consumers and the fisheries SCM. Thus, this review would be a guideline and solution for enhancing the reliability of RFID-based traceability in food SCM systems to ensure the integrity and reducing the opacity and asymmetry in the product information.

Keywords: food safety; sustainability; RFID; technology; fisheries; consumption; traceability

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1. Introduction

In this pandemic era, traceability is a vital safety tool for food supply chain management (SCM) systems, especially for fresh food and live products. To maintain a healthy lifestyle, preferences of quality and secure food are highly demanding as a dietary habit. Therefore, the increasing public awareness about product safety and quality leads consumers concerned about traceable products and foods [1]. Due to the pandemic, aquaculture and capture fisheries have exaggerated a lot. At present, the movement has a significant restriction in many countries of the world as zoonotic disease SARS-CoV-2 (Covid-19) is highly contagious [2]. Moreover, in this Covid-19 era, people are paying more attention to high-quality, secure, and traceable fresh foods, seafood, medicines, etc [3]. However, product information asymmetry, food contamination triggering the outbreak of a crisis in market assurance, disrupted fish production, and logistic chain industries are facing significant losses and the pattern of the client's awareness of safe fish/seafood consumption has also changed [2]. Thus, supervision and monitoring product safety with quality imposes traceability features from production to distribution. Many countries developed and depended on online systems to trace and assess the quality of fresh food in

their SCM system to reduce product asymmetry and moral hazards and achieve incessant food value enhancement [3-4].

With the rapid growth of technologies and wireless communications such as blockchain, internet of service (IoT), wireless sensor networks (WSN), and radio frequency identification (RFID) to trace and assess the safety measures of fresh food or processed food in their SCM process. RFID is a widely used technology worldwide due to its mobility, inventory accuracy, increased security and traceability, real-time information through unique electronic product code (EPC), which is easily accessed online by the customer through a reader [5-7]. Besides, RFID-based traceability in SCM increases asset visibility, expands employee productivity, and mitigates risk, theft, or loss of products. Consequently, developing a traceability solution with an RFID system would be the priority for the retailers and consumers in the SCM system instead of fresh food tracking, fishing industries, and the aquaculture sector [6], [8-9]. At present, the manufacturing/production process involves RFID technology due to its effectiveness and profitability in economic sectors. Additionally, its public acceptability to get all the track records/footprints about obtained foodstuffs and participate in the communication between technology and the entire SCM process [10-13]. As Covid-19 imposes social distancing, so instead of involving large numbers of field workers and administrative staff, the implementation of RFID-based SCM and distribution networks have been much studied as a pilot project or in real life for agri-food business, the fisheries sector, warehouse management, hospital management, and SCM [14-17]. However, researchers conducted many kinds of research on implementing RFID technology in the supply chain, including fresh food SCM, order management, inventory system, and aquaculture sector [18-19].

The fishery supply chain is long and sinuous so the combinations of upstream and downstream components are difficult to manage and trace. It is mainly because the fish industry includes different production and distribution chains, making the tracing of the information very difficult. Therefore, food traceability becomes demanding worldwide in the food SCM system to cut the perceived food risks and raise the consumer's trust. It brings up the concept from the farm to the table for the food sector and as well as for the fish and fish products [20-24]. As a result, existing food safety needed global expansion of new food regulations, so that these will come up with food safety and trade by ensuring high levels of security [25]. An integrated traceability system for the fishery supply chain delivers wide-ranging, constant monitoring of food safety and quality and traceability at the national level however Romania failed to implement it. In terms of Sustainable Development goals (SDGs), potential technologies such as blockchain, RFID, and sensors are encouraged to implement in the food supply chain to cut down contamination levels and surplus food supplies to designated bodies. Moreover, these technologies are eventually popular with consumers due to their visibility over the environment and supplies/products [26-27]. An accurate achievement and implementation of a traceability system significantly reduce the risk exposure of the economic agents from the food chain by helping them to identify, isolate and correct any problem in an efficient and fast way. Thus, ensuring food safety and reducing the negative economic impact of such an incident [16], [28-29]. Researchers discussed on RFID based traceability solution has come up with advantages of persistent monitoring of supply chains, cost reduction, improve and safe processing record with better service [30]. Recent research identified that RFID-based traceability had significant development in the food supply chain sector, agri-foods, fisheries sectors, aquaculture, consumer products, and pharmaceutical [31]. Additionally, recent regulations on fresh food should ensure a contamination-free, quality supply of seafood, which can be traceable. Though this traceability solution is expensive, using this solution will ensure sustainable, safe food supplies containing the whole track data [8], [32-33].

This paper focused on traceability solutions based on RFID technology for the last 15 years of researches/case studies, which have been studied and implemented in many countries for fresh live fish, aquaculture, frozen food cattle/beef, canned tuna processing to distribution, waterless live fish transportation, etc. After that, we have compared the

presence and absence of this technology in terms of its configuration. As a result, tracing out safety measures is accessible and visible throughout processing, packaging, and sealing fresh seafood, significantly decreasing worries that foodstuffs might be polluted. However, even the rise of Covid-19 created concerns among the government, consumers about eating safe seafood or fresh food products. Thus, this review article will ensure a safety traceability guideline for aquaculture producers, distributors, and consumers. Respectively, the whole seafood supply chain process will be automated and vigilant from production to consumption.

2. RFID based Traceability Systems in Agri-food and Fisheries SCM

RFID technology has been widely used in agri-food and fisheries SCM to carry out food safety and quality in the context of post-pandemic conditions. Ensuring trustworthiness between the consumers and the existing market, traceability has become a hot research topic in the field of fisheries SCM for people's health. This section discussed the implemented RFID-based SCM traceability solutions in many countries to collect and track the data history of the fresh fish, seafood, waterless live fish, cold chain, canned fish products, agri-food, cattle/beef, farmed fish.

2.1. Sustainable Supply Chains with Blockchain, IoT, and RFID

Tsolakis et al. (2013) studied the blockchain, IoT, and RFID-based food supply chain traceability, which promoted SDGs to align with the Thai fish industry. Researchers conducted several case studies to test the feasibility of implementing RFID tag-based traceability for canned tuna from processing to marketing. The outcome of this research was to contribute in the field of fish SCM systems about the ultimate impacts of the flexibility of fisheries environments and how this sector could bring into line with SDG Goals 1. In addition, a case study used tuna cans labeled with RFID tags and the overall scenario of processing tuna from fillets to canned for production to set up the traceability purpose [34].

2.2. Fisheries Supply Chain Traceability

Coronado Mondragon (2020), proposed a two-layer conceptual approach for the fisheries sector in 2020. This research utilizes a sensor layer based on WSN theory to model the surrounding energy consumption of a sensor network. This phase collected data from the sensors used for ocean monitoring purposes. The collected data were analyzed using time series/scatter diagrams to get the output. As a result, this identified the trends and patterns of snow crab catch settings. Finally, this approach presents future researchers who can use this approach and develop it as a monitoring tool for fisheries SCM with the help of Internet of Things (IoT) solutions to monitor products and track, among others, using RFID technology [35].

2.3. An Intelligent Traceability System for Waterless Live Fish

Zhang et al. proposed an intelligent traceability platform in 2019, based on the regulation of HACCP. In this method, wireless monitoring facilities were integrated with the quality control modeling to enhance the quality of fish and safety transparency to carriage waterless fish. Therefore, the QR code and the RFID tag's electronic product code (EPC) were combined to enable traceability functions to users for any query regarding tracking. As a result, a quick query regarding safe transportation was visible to the consumers portrayed from aquaculture to markets. In this regard, sturgeon delivery trials were assessed and studied [36].

2.4. A Supply Chain Traceability System for Food Safety based on HACCP, Blockchain & Internet of Things

Tian builds an information platform for real-time food tracing and supply chain system, based on Hazard Analysis and Critical Control Points (HACCP), blockchain, and the Internet of things. This method intends to provide a single platform with openness, transparency, neutrality, reliability, and security to all the supply chain members. The idea behind this method was based on the concept of big chain DB to fill the gap in the reorganized systems at scale [37].

2.5. Developing a Traceability System for Tuna Supply Chains

Kresna et al., developed an Internet Technology (IT) based tuna traceability system for Indonesia as this country is one of the leading tuna exporters with a complex supply chain network. Due to its characteristics and tendency of high contamination, a traceability system was mandatory which could ensure the standard safety and quality tuna supply chain. By implementing this traceability system which ensures safe handling, manufacturing, packaging, and transporting the product as tuna is sensitive to temperature, the content of histamine, quantity of TPC, and contents of bacterial pathogens like Salmonella, and the sanitation for workers, equipment, and processing room. This research prototyped a tracing system, which illustrated the practical proficiencies for backward and forward tracing required for the tuna supply chain from fishing vessels to retailers. Additionally, the system was eligible to permit the biological examination aspects through the monitoring methods of the products [38].

2.6. ePedigree Traceability System for the Agricultural Food Supply Chain

In 2016, Farooq et al. proposed a novel traceability system for the agricultural food supply chain. This research proposed an electronic pedigree (ePedigree) tracking system which employed RFID and sensors to monitor real-time agricultural food, which eventually prevented the hazardous and contaminated supply of food products. In this research, a traceability system named" ePedigree (electronic pedigree)" was developed including RFID and sensor technology, which collects information from agricultural foods in real-time to distribute hazard-free and safe food products. Also, several design/execution features about this proposed system and a feasible consistent solution based on the performance analysis of this research proposed. Nevertheless, the research presents the system's impact on consumer health and safety [39]. Figure 1 shows the overall flow of ePedigree data traceability.

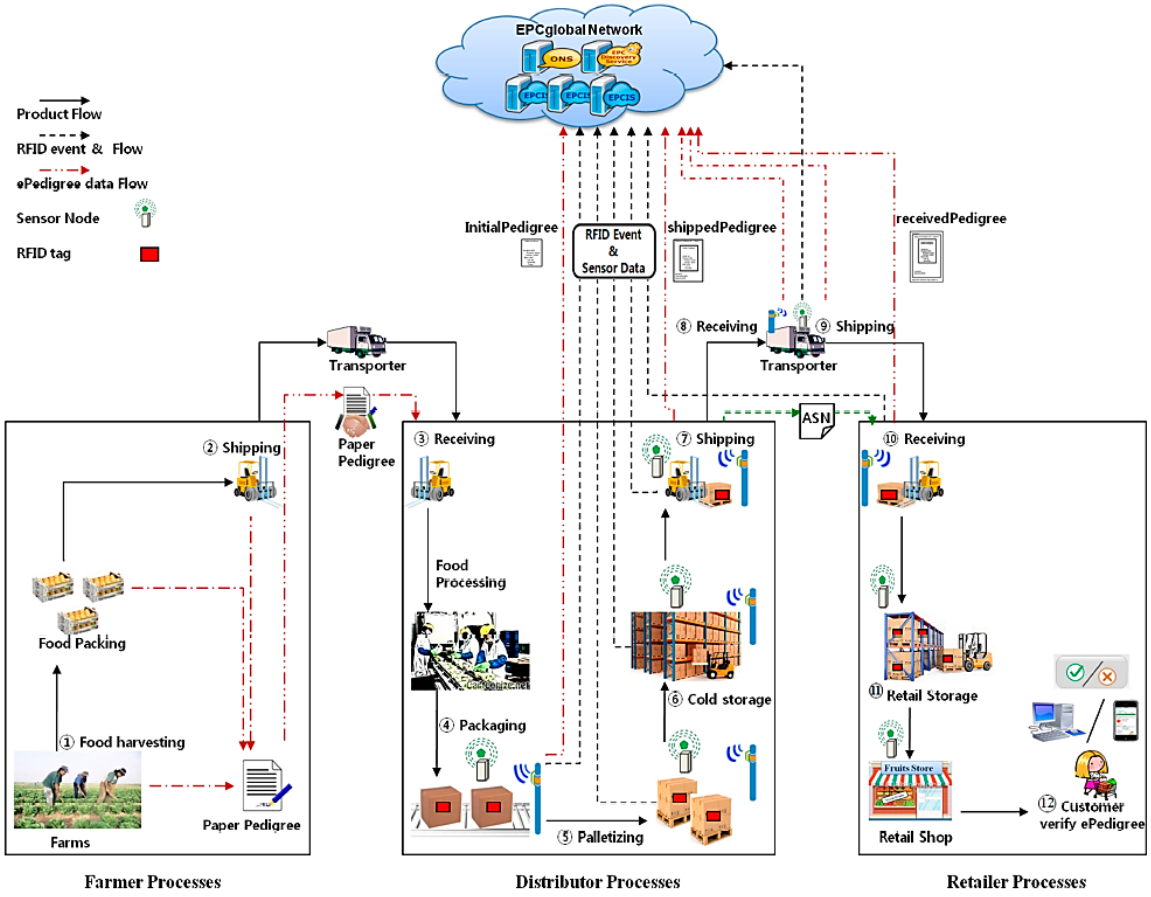

Figure 1. The overall flow of ePedigree data traceability using RFID [39].

2.7. Modeling and Implementation of Cattle/Beef Supply Chain Traceability

In 2015, Liang et al. proposed a cattle/beef supply chain traceability model based on RFID technology along with the EPC global network. The research defines all the transformations of traceability units and the cattle/beef supply chain. After that, the research describes internal acquisition, transformation, and transmission of information. Finally, the authors explained a model for traceability information, collected using the electronic product code information service (EPCIS) framework. In addition, both the software packages Fosstrak and FreePastry used for cattle/beef traceability was implemented based on EPC data. As a result, a case study for real-life implementation including from breeding business, slaughter, process, distribution to sales outlet to evaluate the supply chain for cattle/beef [40]. Figure 2 shows the architectural model of the cattle/beef traceability model.

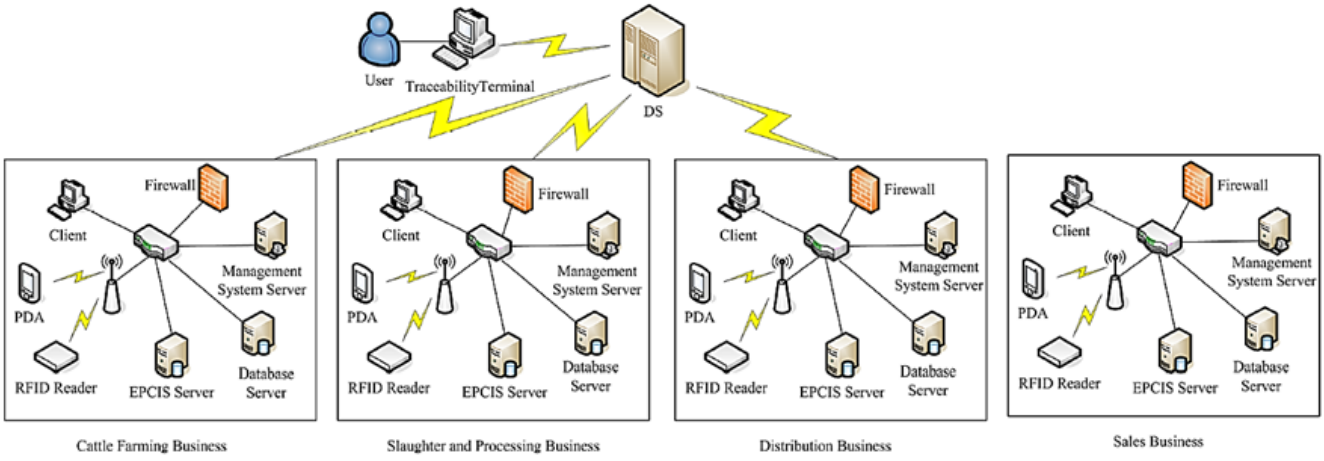

Figure 2. Cattle/beef traceability system architectural model [40].

2.8. Advanced Traceability System in Aquaculture Supply Chain

Parreño-Marchante et al., in 2014, presents a web-based traceability system that captures data utilizing the RFID systems. The system integrates environmental data that were collected through wireless sensor networks (WSN) into that web-based service. Two pilot companies conducted this research with different sizes in the aquaculture sector. The aim was to showcase how the overall business process in the aquaculture sector was benefitted and improved by this solution. The results found that, implementing the traceability solution those companies achieved higher efficiency up to 89-95%, along with activity time reduction. Therefore, KPIs are presented as the time reduction of activities and can improve the efficiency of the companies by 89–95%. However, the acceptance of electronic traceability systems was not as fast as expected for the food supply chain [41].

2.9. Agrifood Supply Chain Traceability using RFID Technology

In 2013, Costa et al. came up with a survey on agri-food supply chain traceability solutions using RFID technology, which provided an extensive overview of the merits and demerits of broad adoption of RFID. This survey aimed to provide an updated analysis on the development of RFID-based technologies, which were designed mainly for agri-food industries. The results of these surveys came up with the information that, implantation of RFID technology in the agri-food sector is growing faster with applicability and opportunities. However, various technical and economic bindings limit real applications of implementing RFID [42].

2.10. Temperature Alerts in Cod Supply Chains Technology

Hammervoll et al, (2021) examined different schemes and selection criteria to create an alert as a decision support medium for fresh food supply chains. Therefore, a cod supply chain was chosen in this research for real-time implementation, where logistic and temperature mapping were measured to collect data to establish temperature alerts. So, temperature data for the environment and the expanded polystyrene boxes contains the packed products were collected. In this scheme, single criteria for ambient temperature resulted in a false alarm compared with the measures of product temperature. Therefore, WSN employed in an authentic supply chain of chilled cod was monitored to get the real scenario and reduce quality losses and minimize waste [43].

2.11. Towards RFID Traceability Systems of Farmed Fish Supply Chain

This research highlights two different examples of farmed fish tracking systems suitable for small and medium-sized enterprises (SMEs). The first one involved changing a

manual data collection method to an electronic RFID-enabled scheme implemented in a small company. This project performed a complete SCM solution for farm fish to selling agencies and private customers. On the other hand, the second example handled a part of the automated process of packing fish labeled with a barcode upgraded by RFID technology. In this case, the aim was to extend the traceability to breeding and on-growing fish farms from a manual data collection process to RFID enabled solution data collection method. The pilot implementation identified as modules that used few mobile RFID readers were fixed and selected in different steps in this proposed design. These modules intend to use a general approach for an automated business procedure [44].

2.12. RFID Based Traceability for Seafood Supply Chain

Mai et al. were investigated the cost-benefit analysis on the fish supply chain in 2010 using RFID-based traceability solution. They aimed to conduct a case study for two firms dealing with different operating steps of the seafood supply chain. In this research, the aim was also to obtain preliminary knowledge regarding the cost/benefits distribution of the project actors. This research provided the tangible, quantifiable benefits of implementing RFID traceability solutions to seafood trading companies. Also, this research suggests the RFID tracking implementation cost beard by the firms and the benefits of using this RFID based solution for using as a future marketing tool with food safety regulations [45].

2.13. RFID Traceability for Fresh Fish Logistic Chain

This research developed a real-time RFID smart tag for tracing and monitoring cold chain food applications. A smart tag and a reader/writer were involved in this method, where the smart tag was attached to the products. These tags consisted of integrated lights, sensors (temperature and humidity), a memory to store product data, and an antenna for RFID tag communications. The memory chip stored the traceability data collected using the sensors. Following this, the research utilizes a wireless reader to read the collected data of the food chain from a 10 cm distance with a mobility option. This method was able to read product data and track records automatically online and monitor temperature conditions of the cold chain. Besides, there is no issue of opening the polystyrene boxes containing the fish and the smart tag in this system so that many tags read simultaneously when they pass through a fully automated reader. Also, the system monitors, using temperature sensors resisted temperature to go down below 0°C for frozen foods to maintain a steady temperature condition. Additionally, humidity sensors made the system sensitive to changes in the storage surroundings [46].

2.14. An RFID-Enabled Traceability System for the Supply Chain of Live Fish

Hsu et al. proposed an RFID-enabled SCM tracking system for live fish. In this research, the necessary information was collected for live fish processing and plans drawn up for the overall management system architecture, targeting small and medium enterprise solutions. In this method, the RFID tag is inserted into each live fish to monitor its movement linked to living fish logistic centers, selling restaurants, and the consumers for identification purposes. To collect all the agribusiness-related information and automated transferring procedure sensors were required, controlled by the PLC. Finally, a web-based solution was involved in this research, which stored all the transferred tracking information of farmers and consumers. In this method, the overall system was implemented and arranged as a trial basis to collect all the valuable live fish information of logistic centers [47].

2.15. RFID-Enabled Traceability in the Food Supply Chain

Kelepouris et al. (2007) determined the fundamental requirements of a traceability solution and the way of addressing the requirements of the RFID technology. They investigated the outline of an information data model of the system architecture, which

provided a feasible supply chain for easy implementation. This research demonstrated that the implementation cost of any traceability system mainly depends on the technological approaches involved. Additionally, this research provided insight into RFID-based traceability solutions for real-life practitioners to meet the requirements along with an appropriate, feasible solution [48].

3. Discussion

Currently, seafood consumers and importing countries have become more vigilant than in previous times to assure food safety and disease-free seafood/fish supplies. Even in this pandemic era, Covid-19 or other zoonotic diseases could readily spread if food safety is not adequately maintained. In July 2020, demand for "Chilean salmon" jumped to "practically zero" in China after tracing an outbreak due to Covid-19 to imported salmon. Besides, experts believe that there is no evidence of the virus transmission through food even though "Ecuadorian shrimp" was also linked to the outbreak [49-51]. Nevertheless, food traders and buyers are still cautious about imported seafood products; even at low prices, seafood/fish demand has reduced due to uncertain food safety. At present, the food supply has been disrupted due to the existence of agrochemicals and the chance of reformation (the Genetically Modified Food). These might be linked with not only for Covid-19 but a consecutive incident due to bird's flu, foot-and-mouth disease, mad cow disease (the Bovine Spongiform Encephalopathy, BSE), and inferior food flood [52-53]. Therefore, in 1997, Euro-Retailer Produce Working group of the EU retail trade group was formed by the European trade groups, which formally created a system again in 2000. The system was formed to work out with the food safety and disease-free agricultural products and provided a standard on "the good agriculture standard (Euro-Retailer Produce Working group, EurepGAP) [54-55]. Also, United States adds and Japan has continuously implemented food traceability solution for ensuring safe consumption. Besides, Australia, India, and China, etc., are in the process of establishing "food security" standards [56-57]. Therefore, it is essential to reinforce the safety measures for a risk-free food supply and increase consumers' self-confidence. As a result, the European Union subsidized the EU project "RFID from Farm to Fork" (RFID-F2F) to establish the internet-based practice of RFID traceability system in the food and drink supply chain [58]. Consequently, various pilot projects developed in several fisheries and cold chain analysis sectors based on temperature monitoring datasets using RFID to improve quality and safety [59].

Modern supply chains have evolved from trace and track to highly complex value networks problem to allow connection between environment to machine, machine to machine, and machine to human. Technology has become a vital source of competitive advantages among suppliers, distributors, manufacturers, and retailers. However, it also creates a challenging task to form a feasible and versatile SCM system. This system expects to verify raw materials, store the product in a limited space in the inventory, maintain the visibility of the product along the chain, and enhance the customer experience in the retail shop. This research highlights numerous challenges encountered by recent literature. An RFID-IoT system includes RFID and IoT technology that emphasizes the connection of all components based on sensors, cheaper processors, and ubiquitous computing. The desire is to improve the technology from the hardware aspect, increase its reliability and minimize the deficiencies during trace and track the product. Therefore, a summarized way of comparing recent research based on their merits and target applications in fish industries is discussed and shown in Table 1.

Table 1. Comparative summary of different traceability schemes in SCM systems. 322

Technology	Application	Advantage	Reference
Blockchain, IoT, and RFID based traceability system	Fish industry	-The outcome of this research will help to implement a real-time process for traceability in blockchain empowered fish supply chains Provide a link between blockchain and traceability design for the fish supply chain	[34]
WSN and RFID based traceability system	Fisheries Sector	-Promoted the visibility of the supply chain without line-of-sight scanning process, which not only saves the excessive workforce cost but also maximizes the business opportunities	[35]
RFID based intelligent traceability system	Waterless fish or aqua-culture transportation	-Reduced contamination level and risks by maintaining temperature level. -Provide a quality control solution with low implementation cost and high endurance outcome -Enhance effectiveness through proper technical references	[36]
Blockchain & Internet of Things (IoT) traceability system	HACCP, Blockchain & Internet of Things (IoT)	-Provides a monopolistic, asymmetric, and opaque structure -Data can be protected from fraud, exploitation, alteration, falsifying, etc.	[37]
IT-based Traceability system	Tuna supply chain	-Permits the monitoring of methods and goods based on microbiological investigation and current SOPs are preserved	[38]
ePedigree traceability system	Agricultural Food Supply Chain	-Ensures social sustainability for customer health and safety	[39]
RFID along with the EPC global network traceability system	Cattle/beef supply chain	-Shares the effective solution and find out the gaps in business information's and traceability of the cattle/beef supply chain	[40]
RFID based traceability using WSN system	Aquaculture supply chain	-Increase the consumer belief through the enhancements in product regulation, groups, supervision of time, and automated process. -An easy traceable solution of the farmed business supply chain by offering a supple, scalable, and interoperable structure	[41]
RFID based traceability system	Agri-food sectors	-Organized literature delivers an effective outline and simplifies a quick content analysis for future researchers to identify the problems	[42]
WSN and RFID based traceability and temperature alert system	Cod supply chain	-Set up of temperature tracking offers a theoretical framework to implement in actual decision support systems	[43]
RFID enabled traceability system	Small and medium-sized enterprises (SMEs) and farm fish industries	-Proposed a flexible, scalable, and interoperable system for traceability -Easily transferrable to farmed fish-based business method	[44]
RFID traceability cost/benefit analysis	Seafood SCM system	-Provides a solution to retain existing customers, improves the product quality, and reduced consumer complaints	[45]
RFID traceability system	Fresh fish logistic chain Cold chain management	-RFID is a conventional traceability tool, which can be used in future business without engaging the human workforce.	[46]

		-Able to read many tags at the same time without tag visibility -More flexible technology in terms of humidity and ecological conditions	
RFID-enabled traceability system	Live Fisheries industries	-To evaluate the benefits of utilizing RFID technology -A valuable guideline for a traceability solution	[47]
RFID-enabled traceability system	Food supply chain	-Suggested a precise high-tech method, by assessing the execution cost based on RFID system	[48]

Table 1 compares the research outcomes of the last 15 years from 2007 to 2021 that have been implemented globally. Though different sectors had chosen to implement traceability solutions using RFID technology in different countries, most pilot cases were expanded their pilot projects to real-time SCM systems. The summary table discusses that the development of the RFID traceability systems is for several sectors of food SCM, including fresh fish, aquaculture, cattle/beef, waterless fish supply, cold chain, seafood supplies from packaging to consumptions. Nevertheless, few research results have been discussed who deal with the RFID traceability solution in the fisheries industry, cold chain, and fresh fish. These results found that RFID-based application in SCM system has benefitted in many ways such as conventional traceability tool, required no engagement of the human workforce, can read many tags information at the same time, maintain visibilities, maximize business opportunities [34-35, 46-47]. In addition, RFID possesses a flexible solution to trace temperature and humidity continuously throughout the SCM process, which have been come up with the research projects mentioned for seafood, aquaculture, cod, tuna, and waterless fish SCM system [36, 38, 43, 45]. Moreover, RFID-based traceability maintains and monitor goods based on microbiological investigation and current Standard Operating Procedures (SOPs). Nevertheless, traceability systems for cattle/beef SCM, agri-food, farmed fish, etc. are also able to provide social sustainability for customer health and safety [39-40, 42, 44, 46, 48]. In addition, utilizing RFID in SCM delivers a compelling solution and finds out the gaps in business pieces of information and trace data. Besides, it would be an effective and simplified solution for quick content analysis to future fish consumers. Moreover, using RFID based traceability system for future SCM will protect track data from fraud, exploitation, alteration, falsifying, etc. [37].

At present, RFID is one of the wireless technologies widely used in many countries for various reasons to track product information remotely with the help of IoT. It is possible to trace and resist the temperature going down below 0^0C for frozen fish logistic chain monitoring. Moreover, maintaining specific humidity is necessary for fresh fish and seafood during the storage process. The feature of sensing the humidity condition also makes RFID more ubiquitous in the fisheries industry. The feature of having real-time demonstration and validation makes it a real-time application in the fresh fish logistic chain. Moreover, it easily tracks the automated system of tracking through RFID tag and reader data and integrated into an online database with the actual condition. Besides, the system reads fresh fish, seafood, frozen food, or even canned food and RFID tag data without exposing any packaging boxes (polystyrene boxes). Additionally, it also reads many RFID tag information simultaneously while automatically passing the reader. It is possible to achieve real-time traceability information from production to consumption to the different food/fish SCM systems. As a result, this maintains safety and quality along with the fisheries logistic chain; this improves the SCM and strengthens the consumers' confidence and belief regarding the fish/seafood logistic chain.

To increase the efficiency of resources and cost, there is a need to further analyze the collected data. Although several studies have proposed RFID data processing and sharing solutions in the supply chain, the cost of computing and efficiency of storage is always neglected [60]. Fortunately, with the emergence of cloud technology these days, the cloud provides an accessible platform of on-demand computing microservices especially on

data exchanging and integration with another system at a lower cost. Instead of developing their system infrastructure from scratch, developers can deploy their applications by "renting" the technology from a cloud service provider. As a result, this helps save the cost of development from software, hardware, and human resources. Furthermore, the developer can also save high maintenance fees as the cloud provider handles many services and can be customized based on the requirement. Additionally, a cloud service provider such as Google Cloud Platform offers "pay-as-you-go" without any up-front and termination fees [61]. This process has encouraged the fast development of Proof of Concept in many applications using minimal cost and resources [62].

In the future, we look forward to more research into innovative SCM processes using RFID tags and readers with higher sensitivity, feasibility, and adaptability. A large amount of data transmission can cause system delay, communication error, and conflict between the retailers and consumers. The challenge has become more complicated when most of the data is collected in real-time by connected devices simultaneously. Once data is collected, the process of analyzing the data, including data validation, cleaning, mining, exploring, and loading requires highly skilled workers and powerful computing hardware such as the Computer Processing Unit (CPU) or Graphic Processing Unit (GPU). Furthermore, the design of the hardware is favorable in miniature, low energy consumption, embedded, and easy to implement with other technologies. Besides that, the lack of seamless integration between the current existing system and the newly developed open-source-based system would be one of the targeted issues. Many proposed systems are in a position of large-scale supply chain production in the fisheries sector. However, the maintenance of the system pipeline, network architecture, and data management is complex, and it causes the plausibility to redesign the whole architecture. At the same time, with the increasing development of RFID devices, it remains a significant challenge to develop a fisheries SCM system infrastructure that can manage massive data within the same network.

4. Conclusions

In this review article, the traceability systems of sustainable and safe fisheries SCM using RFID technology have been discussed. The last 15 years' research outcomes have been discussed that have been implemented in many countries around the world based on traceability using RFID technology. Due to the benefits of RFID technology, it has been found that most pilot cases were expanded to real-time implementation in fisheries SCM. However, fisheries or seafood traceability involving RFID technology has limited execution compared to other food industries. The findings from the literature review show that most of the systems aimed to implement a solution with sensing capability that allows information transfer through RFID technology. The use of RFID technology in fisheries SCM is required to regulate food safety and quality. However, the system's current execution relies on multiple technologies, which causes an increase in the cost of developing the system infrastructure. RFID-based fish or seafood traceability in SCM also will resolve potential technological issues like customer requirements and fast changes in orders. In addition, the cost of operation and adoption of new systems is increased owing to the incompatibility and feasibility of such existing systems. A smooth and feasible project workflow with many coordination efforts is needed to ensure the efficiency of the fisheries SCM while maintaining the overall cost of RFID-based systems. This review explored the rise of sustainable and safe fisheries traceability systems based on RFID technology and consumer's acceptability in SCM. In this way, the fisheries SCM will be able to examine the achievable profit, ensuring sustainable, safe supply, maintaining storage conditions, temperature/humidity, and compare them against the cost of adoption to make a wiser decision.

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