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Development of Blockchain-Based System for Tracking Fish Species' Taxonomy and Conservation Status

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Abstract
Overfishing, illicit fishing, and a lack of transparency in the seafood supply chain are just a few of the many issues that fisheries confront. Blockchain technology combats illicit fishing, ensures quality assurance through immutable data, and makes supply networks transparent and traceable. Meanwhile, AI improves sustainability, resource allocation, and decision-making through ecosystem modelling, predictive analytics, intelligent monitoring systems, and fish stock assessment. The combination of blockchain technology and artificial intelligence (AI) has the potential to revolutionize fisheries management, anyhow obstacles including data privacy, integration, and capacity building. The use of blockchain technology and artificial intelligence (AI) in fisheries management is examined in this study. Future research should concentrate on interoperability, user-friendly interfaces, ongoing innovation, and capacity building to fully use these technologies in supporting sustainable fisheries management practices. Perishable fish is the most traded protein diet. Fish and fish products are in high demand due to rising fish consumption brought on by urbanization. The industry has several difficulties, such as overfishing, improper handling, quality issues, and counterfeit fish supplies.

Keywords: Development (DD), Blockchain Based System (BBS), Tracking Fish Species (TFS), Taxonomy (TT), Conservation Status (CS)

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Introduction

Blockchain-based is a specialized distributed technology system that records, verifies, and transfers data across different computer networks. As we know, the environment is getting polluted daily because of various factors, and it is essential to conserve endangered and extinct Species of different living organisms. Now, a blockchain-based system tracks fish species' taxonomy and conservation status. Many environmental factors threaten the population of fish these days. The first important factor is overfishing. As we know, every species has a specific time to reproduce, so there is a need to balance species' death and reproduction rates. When overfishing is promoted all over the world to meet the increasing demands of the human population, there is an imbalance in the reproduction and utilization rate of fish, which may reduce fish populations to a great extent(van Loon, 2023). The water population is the other important factor in lowering fish populations, as every species needs a specific habitat to exist in nature. The habitats of fishes are freshwater and marine water. So, it is necessary to conserve habitats for species' existence. A recent mechanism that is a database permits sharing such information that is transparent within the scope of the business framework. The phenomenon of a database works in such a way that it is stored in blocks connected to form a chain. A warehouse of data with the capacity to maintain a list that continuously grows all the records that are ordered in a much-arranged way is called a blockchain. The link between these blocks is built by the application of cryptography. Every block has a cryptographic hash that is connected to the previous block. A timestamp and data transaction are also involved (Garniel & Lee, 2023). A technology on the behalf of which digital currency, cryptocurrency, and Bitcoin are based. It is a fundamental

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technology that can build a decentralized digital ledger that can make the exchange of data much more protected between various groups or parties. The taxonomy and conservation of endangered fish species are crucial in preserving biodiversity and sustaining ecosystems. On behalf of traditional classification, there are three major classes of fish in which Agnatha, Chondrichthyes, and Osteichthyes are involved. There are also chances of classification of extinct in those groups, such as their classes. More than half of vertebrate species consist of fish. Among the vertebrate animals, which are approximately of the number of 34000, fish is also one of them. One can use the term fish to describe various vertebrates belonging to different evolutionary lines. It clearly represents forms of life other than that of the taxonomic group(Isabelle & Westerlund, 2022). The distribution of fish species is essential for applying ecology, conservation, and fisheries management. Conservation status is the process of keeping a record of whether the species of plants and animals are in danger of extinction in the region where they live. The conservation status depends on the most recent scientific information built by the scientific groups. This publication was on the IUCN Red List about threatened species. Several factors play a significant role in the determination of the conservation status of a particular species. The leftover number of species, the increase or decrease in the population with time, the success rates of breeding, and the known threats(Feng et al., 2022). Blockchain technology is the technique utilized by the fishery and aquaculture departments to enhance the ability to trace and transparent information in the chain of value (Rosana et al., 2023). It also proves beneficial while fighting all those phenomena related to illegal, unreported, and unregulated finishing. In most cases, blockchain applications are utilized for tracing and telling stories, and sometimes, they can also be used for payment or stimulus. At the horizontal level, the use of Blockchain is significantly less. Like decentralized finance, it allows anglers to have access to capital and introduce their name at the market level. Blockchain technology resolves trust and suitability issue and proves to be a stimulus. Fish products are traded for a long time at domestic and international levels(Tsolakis, Schumacher, Dora, & Kumar, 2023). Fish in raw form passes through many stages and treatments before its final usage. There are also the chances of such happenings with the fish that need to be legal, unreported, and more regulatory. Fishes have to move through distances of vast kilometers. If we consider the examples of activities associated with seafood, they are illegal fishing, mislabeling, counterfeiting, and fraud that is of substitution(Tolentino-Zondervan, Ngoc, & Roskam, 2023). There are various cases of fraud related to seafood, which have been reported many times. However, there are some instances in which such illegal happenings cannot be detected. DNA testing is widespread and can detect only a single species with every analysis, indicating a need for technological advancement to detect mislabeling quickly(White, Viana, Campbell, Elverum, & Bennun, 2021). New approaches are needed to measure such characteristics of seafood based on composition and chemical nature to detect seafood mislabeling. Digitalization is predicted to revolutionize supply chain operations from beginning to end using high-technology applications' technological capabilities. Despite the operational benefits of introducing digital technology, they have been largely ignored in isolation due to the lack of evidence. This study examines the combined implementation of Artificial Intelligence (AI) and Blockchain Technology (BCT) in supply chains to expand operational performance limits and encourage sustainable data monetization growth(Lahoz-Monfort & Magrath, 2021). The mapping payoff demonstrates the crucial importance of AI and BCT in managing digital supply chains and the impacts on sustainability and data monetization, depending on the goals and parameters set by the concerned system and the stakeholders. Ultimately, we developed a unifying framework that captures the essential data elements that must be managed digitally within AI and BCT-connected food supply chains to drive value delivery(Ismail, Nouman, Reza, Vasefi, & Zadeh, 2024; Ismail, Reza, Salameh, Kashani Zadeh, & Vasefi, 2023). The hazards in this industry may be decreased using supply chain management facilitated by technology. The third movement of the current supply chains, information flow, was documented at a lower level. Blockchain technology may track items, guarantee quality, and reduce waste while maintaining a steady flow of information. It could include accurate data for forecasting and analysis. This would improve performance in the quest for competitive advantage and foster trust and collaboration between supply chain participants. Blockchain technology includes cryptocurrency-backed smart contracts, peer-to-peer networks with consensus processes, and shared ledgers. The system distributes the data among several databases and stores transactions in duplicate. Every block is a time-stamped set of transactions from earlier and later blocks identified by a hashtag. The system's openness and integrity are ensured because the transactions are in the form of a shared ledger, which allows participants to obtain a copy and compare it with other transactions (Peirce, Sandland, Schumann, Thompson, & Erickson, 2023). Each system transaction is the result of several mathematical puzzles that are resolved throughout the network. Peer-to-peer network groups that strive to answer these challenges are referred to as miners; another group validates them, and bitcoin is awarded to the first effort that is accepted. The transaction is legitimate, costly, and challenging to reproduce as rewards are collected as processing costs. Assets are represented by blockchain technology as digital tokens that are controlled by a private key.

Research Objective

The main objective of this research is to have an eye on the current situation and views related to future conditions of blockchain applications in fisheries and aquaculture worldwide—a view of literature review by applying Blockchain and global value chain infrastructure. The representation of results shows that the application of Blockchain is based on the needs of markets and competitors.

Literature Review

Researchers reveal that the production of quality shrimp is directly related to water quality. the change in the quality of aquatic water due to water pollution has resulted in the death of the fish population. The shrimp fish population is the most affected by polluted water.in special shrimp-producing aquatic farms, various water parameters are controlled to make the water pollutant-free and safe for shrimp growth(Ahmed, Bijoy, Hemal, & Noori, 2024).Studies claim that the illegal supply of fish is increasing around the world. Blockchain technology is used in aquatic system management to keep a check and balance on such illegal activities. Blockchain technology is designed to integrate data in bulk regarding the fish supply. the data related to the carbon emission effect from the aquatic system is managed through a big data approach with blockchain technology(Alwi, Sasongko, Suryana, & Subagyo, 2024).Scholars suggest that data-related marine SCM is managed using the TOE and SAP approaches. Both these approaches are utilized through an LAP model that evaluates the seafood supply process. the whole process of seafood management is controlled by blockchain technology. blockchain technology ensures that the sustainability of seafood is maintained(Bharathi S et al., 2024).studies suggest that blockchain technology is an effective system for tracking information related to AFSCs (Bosona & Gebresenbet, 2023).Studies claim that fisheries' ecosystem management is crucial for maintaining the quality of fish for fish product manufacturing. information regarding the vessel movements is essential to understanding the fish dynamics. the big data technology used along with Blockchain reveals patterns of fish movement in the aquatic environment.

The hidden Mediterranean fish data is obtained through the blockchain technology. This technology provides detailed information about the hotspot of Mediterranean fish species(Coro, Pavirani, & Ellenbroek, 2024).studies explain that to reduce the pollutants in the environment, the development of bioproducts is increasing. Biodegradable products, when discarded in the environment, result in less pollutant release. PHA is a bioproduct made from different natural substances. the degradation of these substances does not impact the environment badly(D’Almeida & de Albuquerque, 2024).Studies reveal that blockchain technology provides sustainable living facilities for fishermen in rural areas.in rural areas, the fisherman faces a lot of financial problems due to less profit from selling fish. blockchain technology helps overcome the challenges faced by rural fishermen (Enayati, Arlikatti, & Ramesh, 2024).Studies suggest that technological development has resulted in IOT-based devices that provide great applications in different fields. the diversity of IOT-based technology makes its use suitable for many industries(GOUIZA, JEBARI, & REKLAOUI, 2024).studies explain that IoT IoT-based blockchain technology is used in supply management systems to ensure a safe and sustainable supply of fish. DLT is a technology-based system that is integrated into SC of fish(Ismail et al., 2023). Studies have explained that demand for tuna fish is increasing around the world .to supply the world with its tuna supply, illegal tuna hunting teams have been developed. These teams control the illegal supply of tuna. Also, the overproduction of tuna to meet the demand for tuna has disturbed aquatic ecosystems. To overcome this challenge, blockchain technology has been implemented in the aquaculture supply chain(John & Mishra, 2024).studies reveal that a large portion of the earth is surrounded by water. Seventy percent of this water makes an ocean. a large part of this ocean is hidden. To get information regarding the species and their taxa found in the ocean, the UWC system is used. this wireless system provides real-time data about the aquatic species found in the ocean. IoUT is another technology for underwater species identification (Mohsan, Li, Sadiq, Liang, & Khan, 2023).Studies claim that tuna fish is of great commercial importance and is found in oceans. The body of tuna is streamlined,, making its speed in water hard to notice by the naked eye. The study on tuna suggests that they closely resemble swordfish. the largest tuna fish found in oceans is Bluefin tuna, which has more commercial importance than simple tuna fish(Orth, 2023).studies suggest that supplying the world with food is a very difficult task. this task is efficiently carried out using blockchain technology. Blockchain technology safely supplies livestock products to the places where they are in demand the most(Patel, Brahmbhatt, Bariya, Nayak, & Singh, 2023). Also, managing information related to the food supply chain is performed under the head of blockchain technology.

The computed blocking technology efficiently gathers data about the secure transfer of fish products or other goods in the market(Rani, Sharma, & Gupta, 2024).Studies reveal that cyberinfrastructure is a framework used to manage ecological data related to different entities. This framework uses a technology-based system to monitor different ecological niches(Recknagel, 2023).studies suggest that AI is used as a sustainable tool for monitoring environmental challenges and helps in the decision-making process for encouraging sustainable ecosystem development(Rodriguez & Costa, 2024).studies claim that the earth's ocean requires a proper management system to conserve aquatic species. The ocean's biodiversity is maintained with the help of the Blue Ocean Health program. Aquatic species are at risk of declining due to water pollution. The pollutants found in the ocean are controlled using the blue ocean system. This system aims to improve the factors that promote the health of life found in the aquatic environment. To save life below sea, Blockchain and virtual reality technology are used in the aquatic monitoring system (Singh & Kaunert, 2024).studies show that blockchain technology regulated the supply chain and stopped the trend of illegal fishery activities. To protect the species found in aquaculture from illegal fishing activities, the use of blockchain technology is made in the aquaculture framework(Tolentino-Zondervan et al., 2023). Moreover, the main aim of blockchain technology is to conserve the population of different ecosystems.by using its data technology system, Blockchain allows for transparency in the supply chain(Yadav, Shivani, Manda, Sangwan, & Demkiv, 2024).studies claim that aquaculture has been developed to conserve the aquatic population in a habitat suitable for their survival. The natural habitat of most fish species has been declining due to water pollution. Marine aquacultures have been developed using a digitalized system to save such declining species. Blockchain technology is one of the most prominent technologies in marine aquaculture(H. Zhang & Gui, 2023).Studies explain that traditional traceability methods cannot be directly implemented in marine cold chain frameworks. For monitoring such cold marine frameworks, the IoV-IMS framework is utilized(Z. Zhang, Zhu, & Liang, 2024).

Figure 1: Fish tracking system

Blockchains in Fisheries Supply Chain

The fisheries supply chain retained data due to Blockchain and shared ledger technology, which improved data transparency, traceability, and agility while ensuring sustainable seafood. With encryption, decentralization, validation, assurance, and cost savings, every transaction is documented on a blockchain. This technology makes it easier for suppliers, producers, distributors, and retailers to share information by tracking fish in real-time. Fish may sustain harm while being processed, stored, or transported. Contamination can be easily tracked due to blockchain technology. Although the goals of the many blockchains that support fish supply chains differ, they all provide data storage, give the chain responsiveness, lower costs and uncertainty, and guarantee sustainable, safe, and fresh fish products. Fish supply chains benefit from blockchains in several ways, including data storage security, responsiveness, cost and uncertainty reduction, and the assurance of sustainable, healthy, and fresh fish products. Launched in 2016, Project Provenance Ltd. was one of the first seafood value chain initiatives to track canned tuna back to its manufacturers. An SMS from the fishermen recorded the fish, creating a new, permanent asset tagged with a unique ID. Along with the fish, the digitally coded asset travels through the chain to the producer, where each transaction is tracked using RFID, QR codes, or other technologies to save data. The Blockchain would be an auditing tool and data bank when used with ERP (Enterprise Resource Planning). Products with technology-based intelligent tags can be traced to their origin. A blockchain technology created by Atato, a Thai startup, supports the Pacifical Atato project, which tracks skipjack tuna and verifies its MSC certification. The Ethereum-based Blockchain created by Gustav Gerig and Pacifical's acceptance of Atato tracks MSC-certified tuna's BaaS (Block chain as-a-Service) on the global market. It guarantees that ethical and environmentally beneficial fish products are consumed. Overfishing in the Pacific is discouraged by the Blockchain. Solutions built on a SaaS (Software-as-a-Service) blockchain platform help trace seafood, agricultural products, lumber, etc. When combined with WWF and Consen Sys, Tra Seable technologies make it easier to recode end-to-end transportation from the producer to the consumer via a network of middlemen. Ethereum-based technological solutions authenticate and validate seafood, guaranteeing product traceability across the supply chain. Another Ethereum-based blockchain is called Treum. They developed a blockchain to trace fish items from bait to plate in collaboration with WWF and ConsenSys. The data is kept in the database after the seafood from the South Pacific Coasts is geolocated and RFID-tagged. It then passes through the chain, which adds up all of the transactions until it reaches the customer. IBM Food Trust links contributors to a food supply chain using a distributed, eternal, and verifiable record of food system information. Retail behemoths like Walmart, Nestle, Albertsons, and others began to use this Blockchain. From the farm to the shop and, ultimately, to the customer, authorized users have rapid access to pertinent agri-food data. This technology finds and fixes food supply chain inefficiencies. The IBM Food Trust helps brands minimize waste from improper handling while preserving their reputation, freshness, and cleanliness. Food Trust uses Hyperledger, a blockchain technology that allows for a safe, approved network that logs transactions in real-time without the need for proof of work or other calculations. During registration, information about the product lifecycle—from harvesting to manufacture, purchasing to shipping—must be supplied to IBM Food Trust. Additionally, the master data details the factory's locations, capacities, and other details, as well as information on purchasing and selling goods. The system uses the Global Trade Item Number (GTIN) to identify food product data. Another identifier used to identify and track food items in the supply chain system is the Universal Product identifier (UPC). In order to prevent fishing in marine reserves, OpenSC, a joint WWF and BCG Digital Ventures initiative, uses technology to monitor fishing areas. One of the businesses that used OpenSC's technology to track its fish and prawns was Austral Fisheries, a division of the Japanese seafood corporation Maruha Nichiro. A cryptocurrency-activated smart card records real-time data on fish items in OpenSC. It is simple to track down the origins of food ordered from a restaurant.

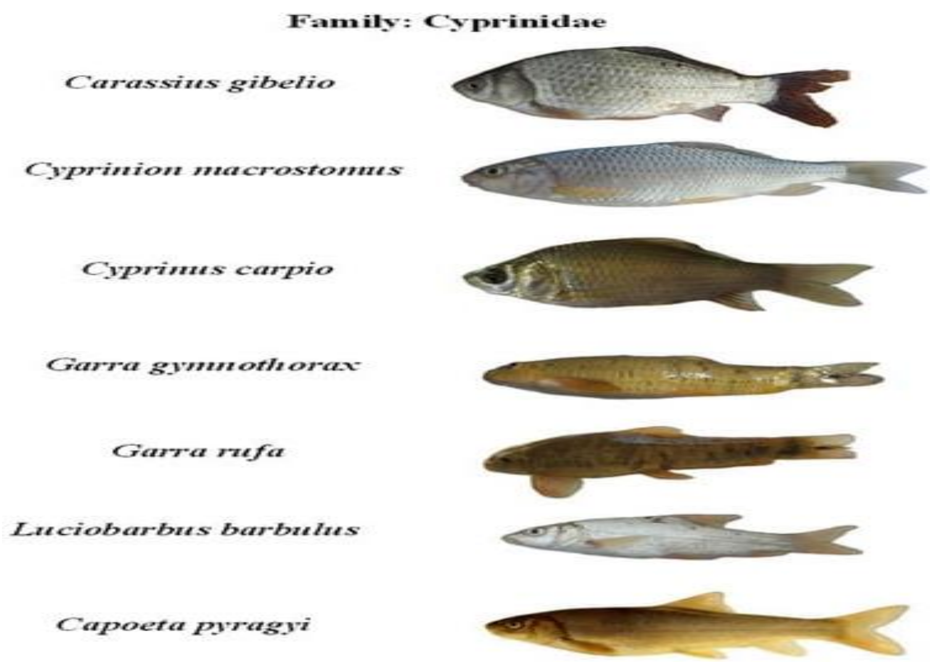

Figure 2: Fish species Taxonomy

Fish Coin

Although this technology is currently in its early stages of development, it can reliably convey seafood information throughout the whole supply chain and encourage data gathering. Using a smartphone or tablet app like mFish (created by Each mile, the same team behind Fish Coin), fishermen or port enumerators would record information about the fish's location, method of capture, landing location, handling, and other details that might be useful to seafood buyers and consumers (i.e. Key Data Elements, which vary among buyers and regulatory entities as they have different data needs). In order to maintain the security of the digital data, it is sent in parallel via a blockchain as the seafood moves from harvesters to the first customer, then to the next, and so on, along the supply chain. Tokens would be used by participants in the Fish Coin ecosystem to "purchase" the digital record, encouraging the gathering of accurate data because faulty data would prohibit the seafood from being sold or the digital record from being transferred to the next buyer. At the time of harvest, while entering another nation, or at other stages in the chain, government inspectors or reliable non-governmental organizations (NGOs) who have no interest in fisheries earnings might verify the digital record. Fish Coin would make it simple for fishermen to convert Fish Coin into cash or mobile phone airtime, as many fishermen are unlikely to value tokens that would be published on cryptocurrency exchanges.

Figure 3: Fish Coin

Discussion

There are many different management objectives for fisheries, and many of them need to be monitored. Without monitoring, there is a greater chance of negative fisheries outcomes, such as low economic performance and fishery depletion, as there is a lack of awareness and accountability for management objectives. Only a small portion of the world's fisheries are probably monitored. This is because many fisheries do not have significant economic incentives or regulatory requirements that would encourage monitoring. Furthermore, several factors make monitoring programs challenging to execute, including the potential resistance of fishermen who have been fishing unrestricted to being held accountable to fishery regulations, the perceived prohibitiveness of monitoring costs, privacy concerns, and prosecutorial systems that may fail to produce harsh enough penalties for violations, which would make monitoring seem pointless. High levels of stakeholder support are also necessary for monitoring systems to be successful, particularly when enforcement is ineffectual. The deployment of a monitoring system might be encouraged in various ways. Although a legal requirement to monitor is frequently a crucial part of execution and can lead to collaboration between fishermen and fisheries management, this is sometimes insufficient. Because ownership of the belief that monitoring will result in better fishing is preferable, stakeholders typically need to be encouraged to adopt a monitoring system beyond the threat of punishment, which is frequently ineffective or nonexistent in some contexts. This can be accomplished using participatory processes to co-create monitoring goals and design monitoring systems. Stakeholder buy-in may be attained by illustrating and explaining the advantages of monitoring for fishermen, which are frequently expressed as better fish prices, more catches, and more sustainability. Each person's motivations for adoption and involvement should be taken into account when creating a monitoring program. Positive monitoring results can strengthen support and participation in enhancing fisheries accountability. Participants would probably perceive monitoring favorably if, for instance, fisheries monitoring protects fishermen's rights by guaranteeing that no illicit fishing is occurring and that scientific data is being utilized to manage the fishery. However, topdown imposition of a monitoring program frequently leads to a waste of time and effort if incentives are not aligned. There are several approaches to fishery monitoring, and they differ in terms of the kinds of data streams produced, the amount of knowledge needed, the required level of stakeholder engagement, the infrastructure needed, and the cost. It is crucial to make sure that the advantages of a certain monitoring method outweigh the expenses. Implementing an intense monitoring system that uses cameras in integrated systems that produce extremely precise data for management is likely beyond the financial means of many fisheries. However, there are now a number of technologies that may be able to accomplish monitoring objectives at a far lesser cost, frequently with greater levels of adoption and uptake. Documenting who is permitted to collect, process, and purchase seafood is frequently the first step in monitoring. A database or list of authorized participants and a grace period to entice fishers to register might be the first steps in this process. Fishermen may find it simpler to enter their registration information using apps on a tablet placed in the middle of fishing villages, maybe with assistance from NGOs or community organizers if needed. Institutional obstacles including poverty, illiteracy, and remoteness (together with the corresponding lack of infrastructure) can often make it difficult for fishermen to participate in a vessel and permission register list. From this vantage point, managers and stakeholders can choose how to close the gaps in monitoring and improve the quality and coverage of data while staying within the limits of current infrastructure and budget. Appreciatively, there are now a lot of inexpensive technologies that can assist close gaps in fisheries monitoring. However, for these technologies to be successful, they need to be properly selected, adjusted, and integrated into a management system and monitoring program that creates incentives for use. To improve the likelihood that monitoring technology will be feasible, affordable, and meet monitoring goals, the design approach for monitoring must be human-centered. There is a chance to mainstream the use of participatory, human-centered design methods and socialize them because technology for fishery monitoring, particularly small-scale fisheries, is still in its infancy. As opposed to programs like Global Fishing Watch and Eyes on the Sea, which use passively generated data to identify illegal fishing operations, this is essential to the development of successful monitoring programs that rely on fishery adoption. This is because the variety of technologies and systems available to fisheries means that there are numerous ways in which fishing communities can choose to interact with them, as well as numerous ways in which technologies may not be adopted or generate useful data. Some electronic logbook programs, for instance, have tabs and inputs that are quite organized, while others provide fishermen greater flexibility when entering logbook data. In a fishery where self-reporting is unreliable and there are several opportunities for input mistakes to occur, selecting an app that permits flexible input might lead to inaccurate data. Additionally, although some monitoring systems are managed and maintained by outside parties, others require the fishing community to do physical and Technologies for Improving Fisheries Monitoring 68 analytical labour (e.g., deploying equipment and using software to analyze fishery data). Every fishery will probably benefit from a distinct combination of technology. Therefore, the design approach must prioritize the demands and capabilities of the fishery itself. Any monitoring program's potential might be hampered by institutional obstacles and a lack of capability. For instance, a number of case studies emphasized the necessity of integrating and streamlining data from several sources, such as the public and corporate sectors, academic institutions, and non-governmental organizations. The quality of the data produced by monitoring will be maximized if this is possible. However, if the government lacks the will or ability to process the data or incorporate it into their system, their efforts can be in vain. As previously mentioned, even though the Deckhand app has been widely used by fishermen and has been the subject of continuous legal disputes since 2013, the Australian government still refuses to acknowledge logbooks created using it. This emphasizes the need to institutionalize processes for evaluating and acting upon the data produced by monitoring technology, as technology by itself will not result in a successful monitoring program. Fishery stakeholders will be sufficiently motivated to invest the time and effort necessary to design and implement technological monitoring systems if the fishery has strong legal mandates and the rule of law, requires a catch history to qualify for catch quota, requires avoiding endangered or depleted species to maintain the fishery, or has a social commitment to monitoring and compliance. The technology they choose will probably be useful and assist them in reaching their management and monitoring objectives if they follow a human-centered design approach, such as the one described in this study. By using technology's ability to provide high-quality data, stakeholders, managers, government organizations, and non-governmental organizations may collaborate to significantly expand the number of fisheries under monitoring. Despite being the least monitored in the world, small-scale fisheries offer a lot of potential to be better monitored. Consequently, these fisheries will be able to realize their full potential in order to preserve ocean biodiversity and ecosystem health for the present and future generations while producing wholesome food, healthy earnings, and sustainable living.

Conclusion

The study discusses blockchain technologies as well as ongoing initiatives related to fish supply and operations. The first pilot initiative, initiative Provenance Ltd., used ERP systems, ICT (Information Communications Technology), and other tools to stop illicit fishing. Since MSC accreditation deters unethical overfishing, Pacifical Atato was more of a branding campaign for tuna. The TraSeable system helps to trace end-to-end fish transactions in a responsive supply chain. The South Pacific fishing sectors rely on Treum, which uses RFID tags and associated technology to track geolocated seafood. In order to ensure real-time transaction recording and stop the spread and consumption of tainted food in international food supply chains, Food Trust monitors farmed prawns and other fish products. Additionally, the coin supporting the transactions and the blockchain technology used are not the same. Blockchains simplify a supply chain, make it more adaptable to changes, and cut down on waste, expenses, and time. Blockchains simplify a supply chain, make it more adaptable to changes, and cut down on waste, expenses, and time. Using blockchain technology improves transparency and lessens inequalities in the supply chain. In addition to building resilience capabilities for overcoming crises, this helps to build effective supply networks. According to the report, blockchain technology should be included into most supply chains, particularly those that deal with perishable goods like fish. The installation will be expensive at first, but it will gradually improve the supply chain's capability and show itself to be effective.

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