



Research Article

AI, Blockchain, ERP, and Machine Learning in Fisheries Supply Chain Optimization: A Systematic Literature Review

Irfan Dadi ¹, Iveline Anne Marie ^{2,*}, Dadang Surjasa ², Juniati Gunawan ³¹ Doctoral Program in Industrial Engineering, Universitas Trisakti, West Jakarta, Indonesia² Department of Industrial Engineering, Universitas Trisakti, West Jakarta, Indonesia³ Faculty of Economic and Business, Universitas Trisakti, West Jakarta, Indonesia*Corresponding Author: iveline.annemarie@trisakti.ac.id

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ABSTRACT

Getting a fully digital infrastructure set up for fisheries has become difficult, yet so has understanding how to develop the infrastructure to improve both sustainability and operability. Fish products are especially troubling because they are so perishable. Coordinating the large number of small fishing businesses (which are the main focus of this paper) is troublesome and causes a lack of ability to trace products throughout the supply chain, and a whole host of other inefficiencies. In an attempt to better understand the challenges of technology integration in small-scale fisheries, this paper presents several case studies of how artificial intelligence, machine learning, blockchain, and enterprise resource planning tools have been implemented in fisheries supply chains. In line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) methodology, the review captures the state of technology in the field by reviewing 111 articles published in the last five years via a systematic search of Scopus and the Web of Science. The bibliometric tool in R was used to process the bibliographic data and ensure a systematic review of the published works. From this analysis, it was found that AI and machine learning tools were primarily used for demand and supply forecasting, whereas blockchain was used to ensure traceability and transparency in the supply chain. ERP tools were used to integrate the logistics, financial, and inventory management systems. While these tools have been implemented, there still appear to be significant barriers to integrating these technologies in a digital ecosystem. The barriers to implementation include high costs, very little digital infrastructure, and a complete unwillingness to adopt the technologies. The review indicates that the use of technology needs to be integrated, and the best way to improve small-scale fisheries is through the use of technology that is flexible, scalable, and can be easily integrated. These solutions lay the groundwork for better sustainable fisheries management. Further down the line, research can focus on creating interconnected systems that make it possible to implement affordable traceability and data-sharing systems, as well as provide real-time decision support across the various stages of the fisheries value chain.

Keywords: Digital infrastructure, artificial intelligence, machine learning, blockchain, ERP, fisheries supply chains

INTRODUCTION

The fisheries sector is being pressured to keep pace with new technologies to meet modern-day requirements around traceability, sustainability and efficiency. Digital transformation has become a must across the fisheries supply chain [1], [2]. However, the fisheries supply chain suffers from persistent traceability issues and is becoming increasingly inefficient with greater demands for sustainability. Given these challenges, numerous digital technologies can help. In creating solutions to improve inefficiency, for example, artificial intelligence and machine learning utilize some degree of predictive analytics. To improve traceability, blockchain technology creates records that are permanent and

unchangeable. To improve the sustainability of operations across various organizations, enterprise resource planning (ERP) systems can be employed [3], [4], [5]. In addition, the challenges of the fisheries supply chain are compounded by the highly perishable nature of fish products, the volatility of supply and demand and a lack of proper communication and coordination (or collaboration) among the various actors and participants in the supply chain [6]. Digital transformation has become a means of addressing market pressures on supply and the urgent need for greater sustainability in the fisheries industry [7], [8], [9].

This research examines real-world models and data examples related to the application of core digital technologies to the fisheries supply chain segments. With an emphasis on use-inspired research, this review seeks to provide practical insights to aid the design and implementation of relevant technologies in fisheries supply chains, drawing on the existing literature. The fisheries industry encompasses a variety of activities, from capture fisheries and aquaculture to docking, processing, distribution and retail. Each stage has its own operational and sustainability problems [10]. Fish products are highly perishable, so careful, precise planning is needed to manage cold chains. There also needs to be timely distribution to prevent spoilage and fraud [11], [12]. There are also issues caused by the many stakeholders involved in a fisheries supply chain, including fishermen and aquaculture farmers, intermediaries, processors, shippers, regulators, export workers, and technology solution providers [8], [13]. Adequate digital transformation is more than just improving technology. It also requires coordination that integrates all stakeholders in the supply chain [14].

New tech could change fisheries supply chains, AI and ML are used to predict demand, optimise routes and assess fish stocks [15], [16]. The ability of Blockchain to maintain a permanent, public record of data enables trust and traceability in the value chain [17], [18], [19], [20], [21]. Also, ERP systems have been increasingly used to consolidate core business functions such as purchasing, stocking, selling, and accounting into a single system, thereby improving business operations and effectiveness [22]. Each of these innovations has been researched extensively. Nevertheless, the literature tends to focus on individual technologies and does not explore integrated research or how combinations of technologies could create unique solutions for improving fisheries supply chains [23], [24], [25].

More studies are examining how blockchain or digital technologies like AI could change supply chains, including those of fisheries. Tsolakakis et al. [1] and Alsharabi et al. [2] examine the use of IoT and blockchain for sustainable fisheries and the use of AI and blockchain for sustainable fisheries. Reyna et al. [3] examine the use of cloud computing and blockchain for the food supply chains. These studies add a lot of value but do not use much tech or focus on the big picture. Also, while many mention that fisheries tech is promising, they do not focus on what needs to be done to implement it in the fishing industry.

This review combines a range of studies and models examining how different technologies can be integrated in fisheries supply chains. It focuses on solutions and challenges in small, developing region fisheries. These fisheries account for a large portion of the al fisheries but have received very little attention. This review aims to examine the feasibility of integrating technologies digitally and the challenges involved. This will be a beneficial approach to furthering the field and to providing a foundation for the large-scale implementation of technologies in the fisheries field.

This review primarily aims to answer the following question: how do AI, ML, blockchain, and ERP technologies currently integrate into fisheries supply chain optimisation, and what are the associated challenges and opportunities for each of these technologies, respectively? This question relates to the primary concern of this review and other reviews on the use of digital technologies to create more sustainable, transparent, and efficient fisheries, given current disruptions in the supply chain and the impacts of climate change [26], [27].

The review examines all peer-reviewed work from 19 to 2024. During this time, there was a significant jump in digital adoption across supply chains due to the COVID-19 outbreak and new policies that encourage data-driven management [28]. The years of the COVID-19 pandemic and policy changes that encourage data-driven management created a context in which digital systems became more impactful. The review covers the entire supply chain from farming to processing to logistics to selling, and is concerned with the relationships between the various systems.

Some recent reviews have focused on artificial intelligence (AI) and blockchain or the Internet of Things (IoT) in the context of fisheries or agri-food supply chains [4], [5], [6], [7]. However, most publications address these technologies in isolation or remain at a conceptual level, failing to synthesise the available empirical evidence. Alsharabi [2] and Ismail [8] explore the interaction between blockchain and AI in fisheries. Still, none of these publications attempts a systematic review of the integration of AI, ML, blockchain, and ERP systems within the broader supply chain context. This study conducts a structured literature review in accordance with the PRISMA guidelines for all four technologies and their integrated applications for traceability, sustainability, and process optimisation. It also examines these technologies in the context of small-scale and fragmented fisheries, and where the challenges of integration and scalability are most evident.

For this review, a digital ecosystem is a system in which AI, ML, analytics, blockchain, and ERP integrate and interoperate based on data standards and governance. It allows participants to continually make independent decisions while remaining mutually aligned. It looks beyond connection and considers how organisations design, manage, and respond to their data.

METHODS

This research includes a snapshot of articles reviewed using the SLR (Systematic Literature Review) methodology based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The articles focus on a review of technologies, including AI, ML, Blockchain, and ERP applications, in the context of fisheries supply chains. The purpose of PRISMA is to provide a more systematic approach to reducing bias and increasing the likelihood of replication [9].

The search used Scopus and Web of Science (WoS). Both of them have a good collection of peer-reviewed journals in technology, supply chain, and fisheries, among other disciplines. The Search was built on a Boolean framework and was focused on titles and abstracts. The search included the following terms:

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fisheries OR "fish supply chain" OR aquaculture) AND ("artificial intelligence" OR AI
OR "machine learning" OR ML OR blockchain OR enterprise resource planning" OR ERP) AND
("supply chain" OR traceability OR sustainability OR digitalization OR digital AND
transformation) .
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The term "Optimisation" was not included, as many studies examining efficiency, cost, and predictive analytics, as well as supply chain coordination, have used neither the term "optimisation" in their titles, abstracts, or keywords. Removing the term resulted in a much more relevant set of results in [10], [11], [12]. To evaluate sensitivity, the keywords and their groupings were systematically varied by testing different supply chain terms. The search focused on the marine supply chain and included the different pair-wise combinations of keywords like "AI" and "blockchain" as well as broader keywords like "digital technology." Each of the different searches was evaluated against a collection of highly cited foundational papers that were identified during the early evaluation. The searches were then refined until the desired results with improved focus were achieved.

The literature search spanned the period from 01 January 2019 to 31 December 2024. Relevant peer-reviewed journal articles published in English were included. These articles also had to describe the use of any or a combination of

Artificial Intelligence (AI), Machine Learning (ML), Blockchain, Enterprise Resource Planning (ERP), in the context of fisheries and aquaculture or in any seafood supply chain. Preference was given to empirical studies that provide relevant insights or to articles that describe (a) conceptual framework(s) or use cases for supply chain optimisation, sustainability, and/or supply chain traceability. Also, only otherwise published articles describing an empirical use case or related to the above scope, and published in fully open access (Gold or Hybrid Gold), were included in this research. Publishing in this way effectively reduces the number of relevant studies. It is true that sources and evidence published in subscription-based domains are restricted, and this is of particular concern to the author at a university that lacks access to these sources. To the extent possible, this related concern is accepted as a methodological limitation.

The standard for the "Subject area in Fishery Supply Chain" was developed using a keyword-based method rather than the databases' subject classifications. The present study had the following inclusion criteria: Any study that had fishery/aquaculture-related terminology (fisheries, aquaculture, seafood, fish supply chain) in the title/abstract/author keywords and the keywords digital technology (AI, ML, Blockchain, ERP) was included.

Database subject area classifications (like Agricultural, Environmental, and Biological Sciences; Business and Management; and Engineering) were used as secondary validation tools to establish discipline-related matches and determine possible outliers. Using these filters as the primary tool for clearing was avoided to prevent possible subjective interpretation and variances between databases. This keyword-based approach ensured transparency, reproducibility, and thematic precision in identifying studies focused on digital technology applications in fisheries supply chains.

To provide full text and promote transparency and reproducibility in the review, only peer-reviewed articles published in Gold or Hybrid Gold open-access journals were included. Clearly, some of the most recent, important studies in operations management, particularly in supply chain management, may be subscription-based, published in journals without open access, and may not be included. Because of this, it is likely that this sample is not complete in terms of advanced, theoretical research in solving optimisation problems, and published in closed-access journals. This is considered a potential publication bias, which refers to problems in the study and will be discussed in relation to the generalizability of the results. Table 1 summarizes the inclusion and exclusion criteria for the review.

Figure 1 shows how articles were selected using the PRISMA framework. The Scopus and WoS databases were searched first. A one-step Boolean query was then used in the TITLE-ABS-KEY fields. An inclusive search string was applied and not split for each database. The approach enabled a uniform search across the databases and eliminated selection bias that occurs in multi-stage queries.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Explicitly mention fisheries, aquaculture, seafood, or fish supply chain terms in the title, abstract, or author keywords • Studies published between 2019 and 2024 • Document type: Article • Publication Stage: Final • Source Type: Journal • Language Publication: English • Document Accessibility: Full Open Access status (Gold, Hybrid Gold) 	<ul style="list-style-type: none"> • The title, abstract, and keywords do not reference fisheries or aquaculture. • Published outside 1 January 2019 and 31 December 2024. Review, conference paper, book chapter, book, editorial, Article in press • Conference proceeding, book, review • Not written in English • Green, bronze, or restricted access articles

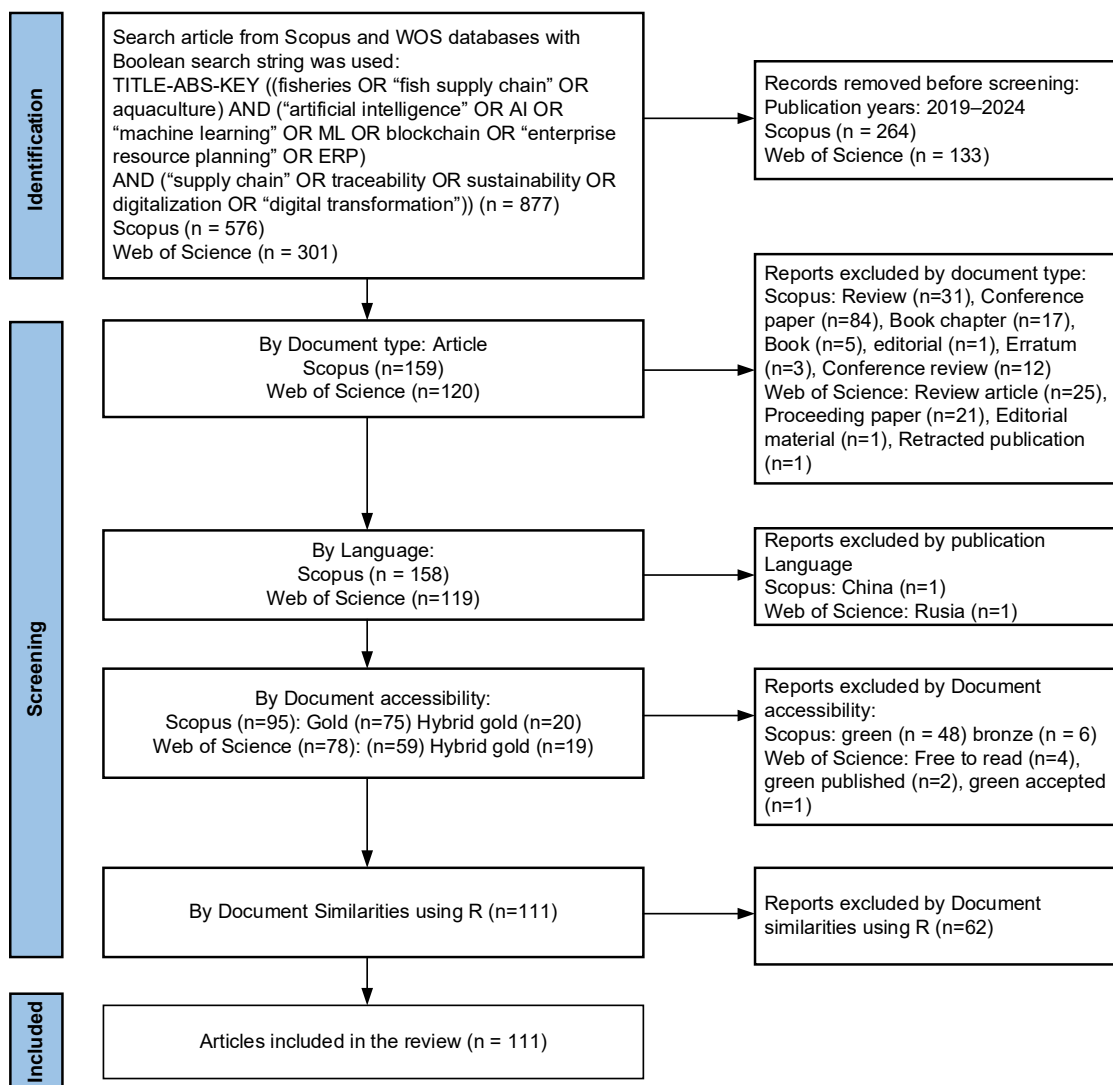


Figure 1. PRISMA flowchart of the literature review

A Boolean search was performed using terms associated with fisheries, combinations of digital technologies (AI, ML, Blockchain, ERP), and the supply chain. This search resulted in 877 records (576 from Scopus and 301 from Web of Science). Records published outside 2019–2024 were removed, resulting in the elimination of 397 records (264 from Scopus and 133 from Web of Science). Next, only peer-reviewed journal articles were retained, and reviews, conference papers, book chapters, books, editorials, errata, and retracted articles were excluded. This left us with 159 articles from Scopus and 120 from Web of Science. Then, articles not published in English were excluded. This meant excluding one Chinese article in Scopus and one Russian article in Web of Science. This left 158 articles in Scopus and 120 articles in Web of Science.

Only articles that are completely open-access and fall under the category of Gold or Hybrid Gold were considered for the analysis. This brought the number of eligible articles to 95 from Scopus (75 Gold and 20 Hybrid Gold) and 78 from Web of Science (59 Gold and 19 Hybrid Gold). All articles classified as Green Open Access (OA), Bronze OA, or with limited access were not considered for the analysis.

The combined Scopus and Web of Science datasets were processed in RStudio (version 4.5.2) using the bibliometrix package to maintain consistency and uniqueness throughout databases. The `convert2df` function was used to convert datasets into bibliographic data frames, and the `mergeDbSources` function was employed to eliminate

duplicates (`remove.duplicated = TRUE`). Refer to Aria and Cuccurullo [13] for further details. The merged dataset was then exported to verify, and a manual screening was performed to remove records that did not contain either a complete author list or an abstract. This data preparation process resulted in 111 unique articles to be evaluated for the systematic review.

A formal quality assessment of all studies included in the review was undertaken to confirm the reliability and validity (integrity) of the evidence synthesised. Each study was reviewed through a checklist based on the PRISMA guidelines to assess the transparency of study design, rigour of the methodology, completion of data reporting, and recognition of potential biases. Assessment of each study was classified as high, moderate, or low quality, and only studies that were above the quality threshold were included in the final synthesis. The review of the quality of studies strengthens the review findings to the exclusion of weaker and more biased studies. This formal, multi-dimensional methodology improved the focus of the review and ensured the inclusion of high-quality, thematically pertinent, and readily available studies.

RESULTS AND DISCUSSION

The data showed increasing interest in research from 2019 to 2024. These technologies were used in a number of steps in the fisheries supply chain, like harvesting, processing, logistics, and retail. The applications of these technologies are summarised in the Table 2.

Table 2 shows, according to the literature, how the different kinds of technology (AI/ML, Blockchain, and ERP) are positioned in the different stages of the fisheries supply chain. With regard to fishing and harvesting, AI and ML technologies aim to increase the efficiency of resource extraction by predicting stock and optimising routes, respectively [8], [30], [31], [47]. In this phase, Blockchain focuses on promoting transparency and accountability in fish sourcing by providing an origin traceability [5], [24]. ERP systems support operational integration and improve resource management of the fleets [40], [41]. The described distribution seems to align with the specific requirements of the supply chain phases. The phases of harvesting and retailing, which are data-intensive and require a high degree of predictive accuracy, are the ones that benefit most from AI and ML [48], [49], [50]. Processing, on the other hand,

Table 2. Applications of Digital Technologies Across Stages of the Fisheries Supply Chain

Stage of Supply Chain	AI/ML Application	Blockchain Application	ERP Application	References
Fishing/Harvesting	Stock prediction, route optimization	Traceability of origin	Fleet resource management, integration with stock systems	[1], [2], [5], [8], [15], [16], [17], [18], [19], [20], [21], [22], [24], [29], [30], [31], [32]
Processing	Quality inspection using image recognition	Product tracking and quality certification	Production planning, compliance tracking	[2], [8], [21], [23], [24], [25], [33], [34], [35]
Distribution and Logistics	Demand forecasting, vehicle routing	Smart contracts for logistics transparency	Warehouse management, inventory control	[2], [8], [25], [28], [34], [36], [37], [38], [39], [40], [41]
Retail and customer	Dynamic pricing model	Provenance data and anti-fraud measures	Sales reporting, financial and customer data integration	[2], [8], [14], [20], [42], [43], [44], [45], [46]

is the phase of the supply chain most strongly impacted by the need for standardisation and compliance and therefore focuses on the use of traceability solutions (Blockchain) and ERP systems [23], [24].

Defect detection uses AI/ML tools in combination with image recognition during quality inspections [51]. For product tracking and quality certification, as well as ERP, Blockchain manages production planning and compliance. AI/ML tools in demand forecasting and routing during distribution and logistics optimally design delivery networks [52]. With the integration of smart contracts, Blockchain improves logistics with transparency, ERP drives warehouse management and inventory control [47], [53], [54].

Pricing models that use AI can change prices automatically at the retail level in reaction to changing market conditions.] AI-enabled dynamic pricing models can adjust retail prices in response to market conditions [55], [56]. Provenance data integrity is ensured by blockchain technology, which includes built-in anti-fraud protection modules. ERP systems include customer and financial data, which improves business decision-making by integrating sales data. These systems develop flexible and adaptive sales intelligence. The referenced table shows the complementarity of these systems across the fisheries supply chain, drawn from a variety of other works. AI-based systems can provide stock predictions to an ERP system that can then be used to direct the integration of harvesting, processing, and distribution activities. While these systems can direct each processing component, they typically function to provide autonomous direction to each stage [41], [57].

In addition to knowing the tech for the different stages of the supply chain, it is essential to understand the structural dynamics of the fishery and its key stakeholders. The fishery supply chain typically encompasses several primary phases: harvesting or aquaculture, landing and sorting, processing, distribution and storage, and ultimately, retail and consumption [49]. Each stage has to deal with the effects of unpredictable environments, slow infrastructure development, and varying demand. Each stage of the supply chain also involves many different people. From fishers to cooperatives to cold storage to certification agencies to distributors to retailers to consumers, everyone is involved. Because of the diverse people and their varying skills and comfort levels with tech, complex, flexible digital solutions are required across different contexts. This is also supported by research showing that small-scale operators in developing areas have a low level of digital readiness [58], and by research supporting the use of blockchain-IoT or hybrid platforms to address the varying needs of different supply chain areas [48], [52].

Integration Challenge

This review shows how AI, ML, blockchain, and ERP used together can help the fisheries supply chain [51]. Each of these technologies has unique and complementary roles. ML and AI improve the accuracy of predictions, which helps with better management of fish stocks and better overall management of fisheries resources [14]. There is no doubt that technology such as blockchain, which contributes to traceability and transparency, will assist fisheries and fish-related businesses in meeting regulatory requirements, and, along with this, will strengthen consumers' trust in the fisheries supply chain [23], [49], [59]. ERP systems promote the smoothest integration of business processes through optimised inter-functional data flow [50], [60]. Although ERP Systems and the technologies mentioned before them have the potential to positively impact various functions of the fisheries supply chain, the majority of these technologies are still in their infancy in working contexts. Many developing regions of the world and small-scale fisheries, which have limited access to resources, are most affected by the barriers of lacking digital infrastructure, high costs of technology, and insufficient training [61], [62], [63].

Scale matters for the seafood industry. Very large exporting seafood companies encounter unique regulatory issues [62], [64]. Smallholder stakeholders encounter more severe challenges, including heightened sensitivity to costs, limited familiarity with digital tools, and greater hesitance toward investment in novel tools and technologies [65], [66]. The disparities indicate that the challenges associated with technology adoption in the context of developing

regions are diverse and go beyond the technological realm [67]. These challenges emerge as a result of systematic constraints and inequalities in the context of structural, infrastructural, institutional, and organisational context and market focus [68]. As a result, the obstacles and challenges to digital transformation in the context of fishery supply chains should primarily be viewed from the perspective of systematic and structural constraints and inequalities of a social and economic nature, rather than simply articulating them as technological challenges [69], [70].

Opportunity for Synergy

A huge problem with research today is that we don't understand how different systems connect to each other and how multiple technologies work together. There are some cases where different AI, ML, blockchain and ERP technologies work together, but those cases are few and far between. Most of the research we do have focuses on research projects or concepts in the early stages and not the systems that are refined and fully developed that the industry actually uses.

All of these systems work together with nonstop data sharing along the analytical, tracking, and operational layers. A great example is how blockchain keeps us informed about the current status and quality of each product. Having this information helps the AI models forecast what the market will demand and helps figure out the optimal price to set. Making use of AI, the recommendations get carried out by the ERP system, which takes control of stock levels, automatically places orders, and modifies pricing. The system works to make the supply chain faster and more efficient.

There aren't a ton of studies on using AI analytics and blockchain in ERP execution systems. The idea behind an integrated digital architecture is really cool. It is super helpful to be able to make decisions based on data in real-time. However, the idea is still pretty far away from reality. Some of the concerns preventing this idea from becoming a reality are how to interoperate the systems, how to standardize the data, and how to govern the frameworks.

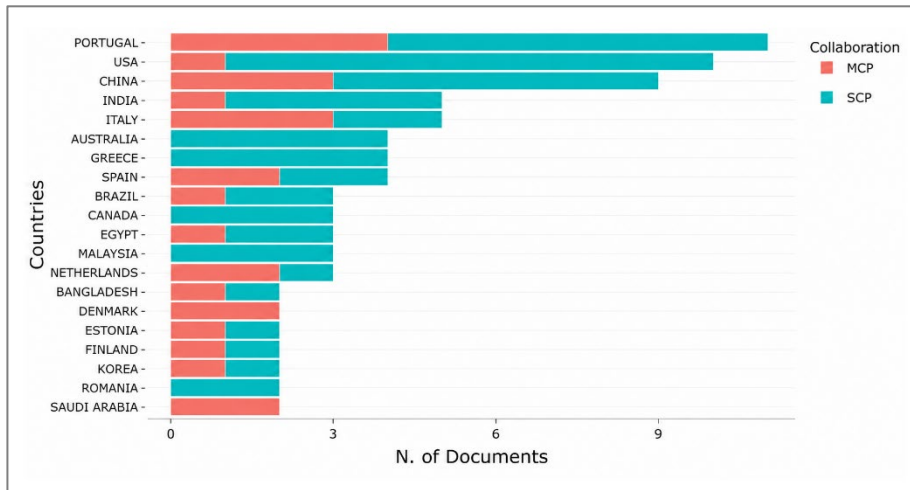
Geographic Trends in Research

Figure 2(a) shows how publications are distributed by country and how they are classified as Single Country Publications (SCP) or Multiple Country Publications (MCP). Portugal, USA, China, India, and Italy have the highest number of publications, but have different results when it comes to collaborations. A high number of Multiple Country Publications is reported for the USA, indicating a high level of collaboration. In comparison, the countries that have higher Single Country Publications numbers have a strong focus on research that is domestically oriented.

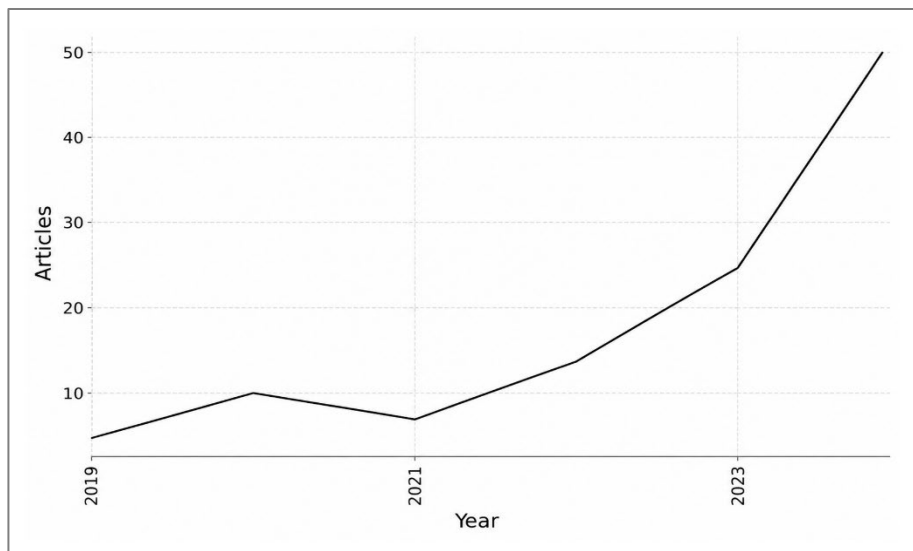
These styles of collaboration show how different kinds of research intertwine and how they have pull. High MCP is often connected to how many different cross-institutional fields and disciplines are brought together for global projects like governance for sustainability, standards for traceability, and digital infrastructure. Many of these international collaborations bring together research of a technical nature, research of an environmental nature, and research of a policy nature, with an emphasis on making an impact and influencing policy. On the other hand, if there are high SCP concentrations, it suggests that the research is more likely to be aligned with country-specific regulations, local structures of industry, or region-specific challenges related to fisheries. Although such research improves the understanding of innovation in a certain context, it might not be accessible on the international level.

Bibliometric indicators can't measure the quality of research or the impact of research on policies. It helps show the degrees of global integration and interdisciplinary engagement. Future research can assess if the international research publications that are focused on the MCP show a greater instance of research with applied outcomes, a greater citation impact, or a greater impact on policies than the research that is focused on the local or national level.

From where research gets done, we can see that advanced nations are the leaders in research. There is very little research done in Africa and the Pacific Islands. These are the gaps that prevent many possible research applications.



(a) Documents by country



(b) Annual scientific production

Figure 2. Distribution and trends of scientific output

Some new technologies and AI predict that blockchain and ERP integrations will be important advances in the future. These have really never been tested in regions that have little to no infrastructure. These technologies will have the greatest impact there. The model may not reflect the real situation. For example, some recommendations made to address the needs of small-scale fisheries in developing nations may actually be misplaced.

Figure 2(b) shows how many times AI, Machine Learning, Blockchain, Digital Technologies, and ERP have been published from 2019 to 2024 in papers about the Fishery Supply Chain. In this time period, the number of publications advanced drastically. In 2019, it appeared very rarely in publications. From 2019 to 2021, growth was minimal, but starting in 2022, there was an explosion in publications on these topics. By 2023 and 2024, related publications appeared in three times as often as before. This shows active interest and research focus in the Fishery Supply Chain. This confirmed that advanced technologies support in maintaining sustainability, enable transparency in logistics and improve the efficiency of the Supply Chain.

Figure 3 shows the contributing authors, their countries, and the most-used keywords. Most keywords illustrate major research clusters and regional preferences. Most keywords used by authors from Portugal [59], [60] and from

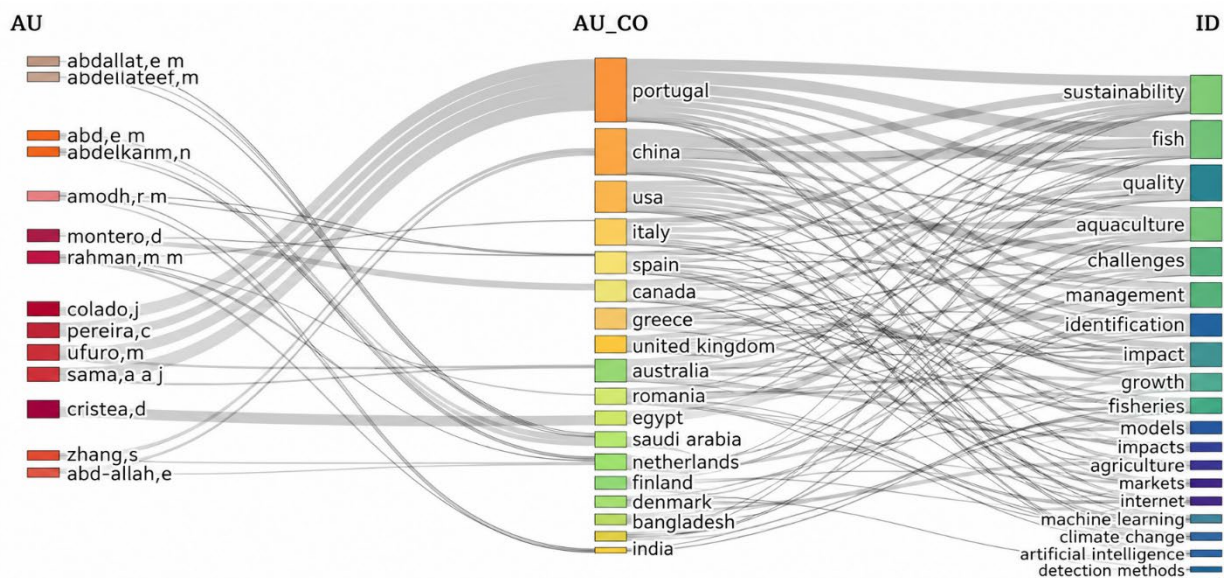


Figure 3. Three-field plot research development

China [50], [61], [62] are “sustainability,” “fish,” and “aquaculture.” These keywords indicate a focus on research into environmental management and fisheries production management. Most keywords used by authors from the United States [58], [63] and Italy [64] are “identification,” “impact,” “internet,” and “machine learning.” These authors appear to focus more on research into technology and data use. These keywords indicate that the major research focus per region is, for instance, sustainability-oriented research in Europe and, in North America, the use of digital technology and computational modelling. Therefore, this figure shows that the region where the research is conducted greatly influences its focus, thereby creating different research agendas.

A shift from theoretical to applied or empirical approaches is observed. An increase in publications in 2023 and 2024 is evident, with real-world examples, case studies, pilot studies, and field-based empirical evaluations being incorporated. Some examples of these publications, in no particular order, include the use of blockchain to conduct traceability studies, the use of field data to validate species identification through AI, and the incorporation of ERP into field production models in the field of Fisheries. Looking back in 2019 and part of 2020, the majority of studies were based on concepts and simulations. In recent years, a trend in the opposite direction has been observed, with a shift from theoretical to practical approaches.

Common themes were identified across the reviewed studies. Figure 4 presents the thematic map, which is divided into four quadrants based on importance (centrality) and development (density): motor themes, niche themes, emerging or declining themes, and basic themes. This map is a good way to show the patterns in current studies, but it doesn't indicate the research priorities for the future.

“Blockchain,” “Artificial Intelligence” (AI), “traceability,” and similar topics comprise the Basic Themes quadrant. These concepts show lower levels of internal density and are therefore connected to the broader field; however, they are largely underdeveloped. The Basic Themes quadrant is dominated by “blockchain” due to the rapid development and the growing demand for transparency and accountability in the fisheries supply chain.

‘ERP’ is placed around the Niche Themes quadrant. It has higher internal density but lower centrality. This means it is a specialized area less connected with the main digital transformation discussions relative to AI, machine learning and blockchain. This may be more related to ERP’s established place in management research and less to a reduced place of importance in the field.

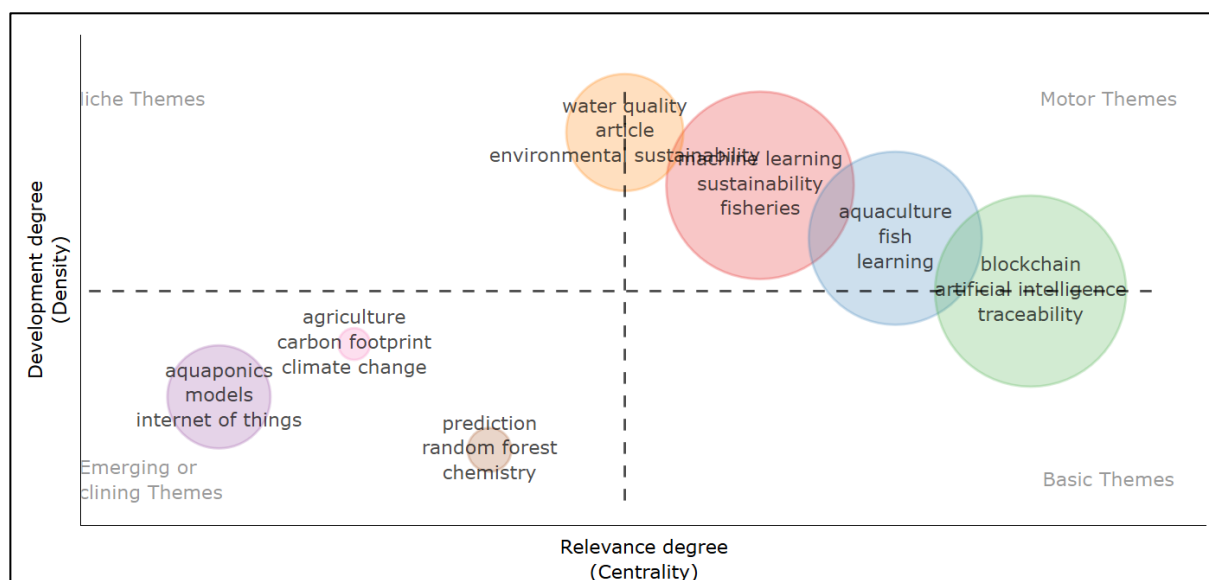


Figure 4. Thematic research map

This shows how research conversations have changed, rather than how they have been prioritized. Centrality is a measure of how topics are connected and is heavily influenced by an emerging trend, as well as sponsorship and publishing. Keywords like blockchain and traceability are the most popular. Their dominating presence does not lessen the importance of integrated operational systems. Instead, it shows the continued fragmentation of research in digital transformation across various technological domains. Integrating these areas of research, such as how ERP systems may combine with AI analytics and blockchain traceability, creates the potential to build integrated, scalable digital systems in the fisheries supply chain.

All studies show that sustainability is now of utmost importance [71]. The integration of AI/ML enables fishing operations to become more precise, efficient, and sustainable, thereby significantly reducing waste. Furthermore, when coupled with blockchain technology, these operations gain accountability, allowing for the verifiable authentication of sustainability claims. Even with the potential these technologies offer, the negative effects in the market & social sphere aren't well documented and should be researched. The adoption of these systems faces several issues. The main issues include the cost of technology, poor technological infrastructure and low technological skills among potential early adopters of the systems [31], [72]. Even with the social and economic barriers faced in the less developed world, the small fishing operators don't have the funds to integrate poorer systems along with the capital [73], [74], [75].

Before presenting the findings of this review, it is necessary to contextualize the methodological quality of the included studies. Some of the studies employ robust methodologies, a significant portion relies on theoretical models, simulations, or small-scale case studies, which often lack generalizability. Consequently, it would be premature to draw definitive conclusions regarding the impact of emerging technologies such as artificial intelligence and machine learning (AI/ML), blockchain, and enterprise resource planning (ERP) systems on real-world fisheries supply chains. It's important to recognise the limitations of the studies in order to appropriately discuss the results and avoid drawing conclusions about the entire industry when assessing the impact of the technologies.

Verifiable empirical data, particularly from longitudinal studies assessing the long-term impacts of these technologies, remain scarce. Studies that show technology success are more likely to be published than those that show technology failures or the challenges faced when implementing the technology. There is also selection bias because more studies are conducted in more technologically advanced regions.

This review agrees that there are some limitations to this study. This review may also have omitted some relevant studies because only English-language, peer-reviewed manuscripts were included. This may have resulted in some relevant studies being left out, including those published in other languages, in the form of industry reports or in grey literature. Due to the differing focal points and methodologies of the studies, a quantitative synthesis or comparative analysis in this review is also a challenge.

There are some restrictions, but the review explains how digital technologies are changing the fisheries industry. Findings show how digital technologies are answering major research questions and their impacts on theory, practice, and policy. AI, ML, blockchain, and ERP create digital technologies that currently work in isolation. This shows what some focus on in research working in digital convergence. The results show the practitioner community the importance of moving toward digital ecosystems. The results suggest to the policymaking community the need for supportive regulations and incentives to apply multiple technologies, especially in low-resource situations.

Research Gaps and Future Directions

Limited use of integrated systems is currently observed; however, significant potential is identified in the integration of AI, blockchain, and ERP. These systems can be combined to address data governance challenges and to enable the development of an interoperable infrastructure. This is a new area of research for the complete digital transformation of the fisheries supply chain.

Digital solutions can improve certification procedures, support decision-making, and provide instant feedback while also reducing duplicate needs. These benefits can be built upon as long as work is done to improve the system, training, and the company's adaptation to new solutions. Digital transformation in fisheries is a wide-ranging change across multiple systems and processes within the company, rather than just adopting the latest technology.

There are many social and technical factors that affect adoption in emerging markets. Some social and technical factors may include the high cost of technologies, limited infrastructure and digital readiness. These factors are deficiencies in institutions, resources, and communities. They also affect the perception of risk and value, as well as the willingness to mobilise resources to adopt a technology. The availability of technology alone is not sufficient to achieve the desired changes; awareness of how such technology is applied in real-world contexts is also required. Many of the existing models ignore informal and small-scale fisheries. Models such as TAM and DOI are widely used, but in many cases, these models need to be adjusted for the social, economic and informal sectors and for community-based fisheries. Digital tools should be flexible and easy to modify for small-scale fishers. Financial support, digital skills training, and cross-sector collaboration to reduce inequality and bridge the gap between the digitally connected and the digitally excluded should be included in policies.

Current research is pretty sparse on how Integrated Technology (IT) is deployed and on the various locations where IT is used. There is also hardly any research on the different community impacts and on how IT is used in a more sustainable way. It will be important for future research to develop new interdisciplinary integrations and models in the area of digital innovation and IT. It will also be important for future research to develop new models in the area of social and environmental resilience. It is expected that the use of IT in fisheries will be highly dependent on the regulatory and policy frameworks put in place to support IT in fisheries. It will also be very important to have a supportive policy framework in place.

To sum it up, Technologies like AI, ML, blockchain, and ERP have unique features and benefits, but when used together, the real benefits and the most innovative results can be seen. They need to be integrated. In order to do that, practices and theories need to be connected, collaboration between different industries is important, and policies should be created to ensure fairness, sustainability, and promote the use of integrated, interlinked systems.

The continued advancement of digital fisheries depends on ongoing technological progress and the development of integrated, inclusive, and flexible approaches.

CONCLUSION

This systematic literature review covers the use of Artificial Intelligence (AI), Machine Learning (ML), Blockchain and Enterprise Resource Planning (ERP) in smart, integrated ways to enhance fisheries supply chains, and current studies indicate their maximum benefit occurs when integrated into compatibly interconnected digital systems. However, the majority of studies to date assess the tools in isolation, and this has hindered understanding of the potential of data sharing and system integration to improve transparency and efficiency in the fisheries supply chain. This review shows a gap in the theory, and there is nothing that provides a clear context on how AI/ML, blockchain, and ERP systems can be integrated and connected as part of a larger social and technical system, while this review focuses on the digital ecosystem of the agri-food and fishery supply chain and shows the importance of data interoperability, shared data, and coordination for future research. The review shows how digital solutions help the fishing industry by addressing key supply chain challenges, and in addition, using data in combination with blockchain systems would strengthen efforts to combat illegal, unreported, and unregulated fishing, and these examples illustrate that the focus of the integration is on coordinating operations.

Nonetheless, there are structural issues in making this vision a reality, and the combination of high levels of invested capital, inadequate infrastructure, incomplete governance, low digital skills, and organisational reluctance means there are more serious issues than just the difficulties of transition; therefore, the move towards integrated digital systems should be seen as a long-term commitment to structural change rather than an easy technological improvement. When making policies or management strategies, both systems and technology need to be addressed, and they also need to be flexible and designed to be built upon. This will also help decide what else gets researched, and testing the joint use of AI/ML, blockchain, and ERP in certain supply chain segments needs to happen first, with this mattering most when looking at post-harvest handling and distribution, and this inefficiency directly results in food loss and income loss. It is a good practice to acknowledge the boundaries of our method for this review, and this analysis only reviewed published articles in English journals; thus, the findings represent the limits of published research, not the limits of all research knowledge. In summary, using new technology to improve the supply chain in the fish industry is an emerging area of study, and the use of AI, ML, blockchain, and ERP will provide more efficient systems.

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CONFLICT OF INTEREST

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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AUTHORS BIOGRAPHY

Irfan Dadi is a doctoral student in the Industrial Engineering program, Faculty of Industrial Technology, Universitas Trisakti. His research interests focus on the integration of digital technologies, particularly AI, Blockchain, and ERP, into the optimization of supply chains.

Iveline Anne Marie is a lecturer and researcher at the Industrial Engineering program, Faculty of Industrial Technology, Universitas Trisakti. Her academic expertise includes Supply Chain Management, Lean Production Systems, Operations Management, Facility Planning, and Sustainability.

Dadang Surjasa is a lecturer and researcher at the Industrial Engineering program, Faculty of Industrial Technology, Universitas Trisakti, with expertise in Supply Chain Management and Quality Management Systems. His research explores the integration of quality frameworks and logistics strategies to enhance operational excellence in both industrial and public sector contexts.

Juniati Gunawan is a Professor in Sustainability Accounting & Reporting at Universitas Trisakti. Her areas of expertise include Sustainability Reporting, Integrated Reporting, Corporate Social Responsibility (CSR), and Social and Environmental Accounting. She has published extensively on the role of transparency and accountability in supporting sustainable development, particularly in emerging economies.