

Chapter 23

Sustainable Aquaculture Development Using Cloud Computing

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ABSTRACT

This chapter explores the infusion of digital technologies into marine fisheries by considering how the transformative effects of IoT, AI, cloud computing, and blockchain are innovatively integrated. It further elaborates on the details of IoT-driven appliances such as drones and underwater sensors in the collection of relevant data from the aquaculture environment. The AI then processes and analyzes such information to yield actionable insights for efficiency improvement. Additionally, the chapter discusses how cloud computing makes big data volumes manageable and flexible. The chapter further narrates blockchain's critical role in trust and transparency within seafood supply chains. Case studies of the Norwegian approach to smart aquaculture and sustainable shrimp farming in Vietnam are covered as well. The chapter elaborates on the aspects that address pollution, propel economic growth, and promote social equity through IoT, AI, big data, and blockchain.

1. INTRODUCTION

Aquaculture has long been a vital source of food and nutrition, providing essential proteins to populations worldwide. With challenges increasing within the industry like disease outbreaks, inefficiency in resource utilization, and the added strain of environmental concerns, digital technology is emerging as the transformative solution for a more sustainable and efficient future. Sustainable aquaculture also utilizes advanced technologies such as cloud computing and its application with IoT, sensors, and analytics-driven real-time data processing for efficiency and effective management of the environment. Cloud-based systems allow reliable and efficient monitoring and control of business processes in aquaculture

DOI: 10.4018/979-8-3693-8034-5.ch023

through the processes facilitated by IoT, sensors, and real-time data processing. Such an approach can reduce resource wastage, support optimal fish health, and encourage eco-friendly practices.

The use of IoT technology has transformed marine fisheries into highly impactful activities to improve aquaculture, fishing, and total supply chain management. IoT solutions help ensure sustainable fishery management as its applications progress for advanced environmental monitoring, tracking of fish behavior, and collection of data. In marine aquaculture, big data are the new essentials in data management as well as storage. With advanced techniques like IoT and AI, data is thus collected, analyzed, and visualized to improve processes in aquaculture with better decisions and sustainability across the industry.

The Internet of Things and big data technologies have extensively expanded the capacity for collecting data in marine fisheries. With AI, such data analysis becomes very efficient; hence, faster decision-making processes are important for sustainable management of marine aquaculture. This transforms the potential of blockchain in this marine fishery industry to allow data sharing, traceability, and resource management throughout the nodes of an IoT network, given the decentralized nature that ensures real transparency, security, and sustainable management.

Deep-sea aquaculture is an emerging practice aimed at overcoming the shortcomings of coastal farming by rearing fish and other seafood animals far out into the open waters. The top countries innovating in this field include Norway, China, the U.S., and Japan, which highly incorporate advanced technologies in their manners to ensure a bigger sustainable supply to the whole world's need for seafood.

Aquaculture is one of the most vital food sources for people around the world, but this industry has sustainability issues with, for example, high water usage, poor feed practices, and periodic disease outbreaks. Aquaponics is a combined system that integrates aquaculture with hydroponics and recycles nutrients to generate a more sustainable system with less resource waste. Norway is one country that has been in a global leading position in aquaculture, particularly salmon farming, after integrating advanced digital technologies to induce sustainable development. This technology approach solves some of the challenges traditional farmers have: water pollution, an outbreak of diseases, and improper use of resources.

Considering the numerous technological strides, the smart aquaculture system introduction still has many drawbacks that discourage small-scale farmers. Issues, such as high installation costs, difficulty in maintaining the system, and lack of data security and privacy anxieties, need to be alleviated so such innovative solutions gain wider acceptance.

2. CHALLENGES FACED IN TRADITIONAL AQUACULTURE

Aquaculture has been vital for the world's food supply. It is a key protein source. However, its efficiency and sustainability are facing several key challenges. The fish farming industry faces disease outbreaks, resource waste, and high carbon emissions. These issues push it towards innovative solutions. Traditional fish farms often have disease outbreaks and overcrowding. This leads to big losses. It also threatens fisheries management. This is vital in areas that depend on fish farming for food. Small-scale farmers are hit the hardest. They lack the resources to tackle these problems.

Feed and water also become very inefficient in traditional fish farming. Uneaten feed pollutes water bodies. This leads to water depletion and eutrophication, harming ecosystems. Traditional fish farming raises the carbon footprint. It often relies on diesel pumps and wild-caught fish for feed.

In these areas, fish farming companies adapt to the latest in digital technologies. Precision fish farming is like precision agriculture. It uses sensor-based data-enabled equipment to track water quality, temperature, and oxygen levels. This controls disease and optimizes growth conditions for healthier and more resilient fish. Using AI and blockchain in aquaculture can boost resource efficiency, cut waste, and promote sustainability.

By blending traditional and modern methods, aquaculture can meet today's seafood demand while safeguarding oceans and communities for the future. With the rising population, the push for smart fish farming is vital. This approach ensures long-term food security and protects the environment.

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