# Application of technological system based on processes modelling and analysis: a case study in Italian Aquaculture Company

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**Abstract.** Aquaculture is a growing sector and could satisfy the future worldwide fish demand. New sustainable consumption patterns arise from food market, based on the consumer' need to know more information about food product. Technological and methodological innovations are needed to create more efficiency in aquaculture industry, but also to create product able to respond to the emerging market needs. The paper shows a case study in Aquaculture Company useful to demonstrate how collect product and production processes information and use it for traceability purpose. Starting from the as-is production process analysis and modelling, several strategically information for consumer are identified. The possibility of using the devices developed in S.E.A. research project has been exploited to collect some of this information and a new traceability layer was create in order to collect manually the missing data. At last the new production process was modelled. The benefits of the system were explained and the follow-up discussed.

## 1. Introduction

According to FAO forecasts, in 2030 the demand for fish will be about 261,2 million tons. In order to meet this worldwide demand, therefore, the 62% of fish products will be produced using aquaculture techniques, as an alternative to wild fisheries captured [1]. So, it is necessary take into account several issues of aquaculture industry improving: quality and safety of fish, health and well-belling of animals during their life cycle, operators' safety during production activities and aquaculture sustainability from environmental, economic and social [2] points of view. From literature background arose as sustainable production methods are strategic issue also for consumers [3,4]. Implementing sustainable practices could provide an opportunity to differentiate the companies' value proposition [5]. Sustainable aquaculture is assumed to match the demand of a particular consumer segment that appreciates additional environmental and ethical values of products [6–8]. More recently, in addition to sustainability issues, concerns about animal welfare are becoming more relevant in public opinion and also in consumers' food demand [9,10].

Taking account this scenario, the purpose of the study was to propose a new concept of integrated smart system able to supply to the final consumer detailed information about fish produced in aquaculture plant. So, the following central research question guides the study:
*RQ – How to collect the data coming from the fish production process in order to satisfy new emerging food traceability demand of the consumer?*
The present work represents a follow-up of a R&S project accomplished in Italian country (S.E.A. - www.clustersea.it) that aimed to foster the environmental and economic sustainability of Aquaculture Industry through the development of an innovative solution for aquaculture plant. The S.E.A. devices (described in [11]) were perfectly integrate with existing structures and allow the company to obtain data about production. The elaboration of this data could provide different type of information. The challenge consists into recovery the information from different activities, actors and device and makes it shareable with final consumer, following the food traceability point of view.

## 2. Materials and methods

In order to answer to the new emergent consumer needs about sustainability and ethical values in food production and leveraging on S.E.A. system, the case study method [12,13] was chosen analysing the operative scenario of the aquaculture company involved in S.E.A. as partner. This qualitative method is able to examine contemporary real-life situations and provide the basis for the application of ideas and extension of method [14]. The purpose of the case study is to analyse, from one side, the company' production process in order to understand in which activity/actor/device resides the information needed by the market and, on the other side, evaluate how the technology already developed in S.E.A. can provide and make shareable this information. The tool used to realize the case study was the qualitative face-to-face interview [13]. The interview was based in a set of questions useful to investigate how the employees operate during daily working activities and was completed by the following information: time, data and place of interview, company role of the interviewee. The interview protocol foresaw that the researchers record information by audiotaping, so the answers was transcript and used to model business process. The interviewees hold four different roles (Plant Manager, Production Operator, Maintenance Operator and Diver) and provide the information useful to model the fish production process using BPMN (Business Process Model Notation) methodology and Signavio tool (www.signavio.com).

## 3. Collect fish traceability information during aquaculture production, case study

From literature analysis arise as consumer wants to know more information about food product (see [15]). Three main categories of information were taken into account for Aquaculture Industry: information about the product (P), information about the production environment (PE) and information about the company (C). **Table *1*** summarizes a short description of the S.E.A. devices, the data that each S.E.A. device is able to collect and the related category of information. For more details about S.E.A. devices see [11].

**Table 1.** Traceability data collected automatically by S.E.A. devices.

| ***SEA Device*** | ***Data*** | ***Categories of information*** |
|---|---|---|
| **Device for biomass forecast** - based on stereoscopic vision, the device realizes a non-invasive statistical measure. It uses a set of algorithms of Computer Vision science and the length-weight parameters for the fish, in order to monitor fish growth curve. | Fish average weight, | P |
| | Fish growth rate. | P |
| **Device for marine data collection and forecast** - it measures waves and currents, and other relevant variables (e.g. chlorophyll, phytoplankton, dissolved molecular oxygen and nitrate/phosphate concentration). All are modelled at different depths in order to | Water temperature | PE |
| | Cage Position | PE |
| | PH | PE |

| | | |
|---|---|---|
| identify potential biogeochemical alteration around the cages. | Water turbidity | PE |
| | Salinity water | PE |
| | Oxygen dissolved in water | PE |
| **Device for fish farm cages monitoring** - it is composed by an underwater device equipped with a video camera and a web application for video stream management, in order to identify and select interesting frame about an anomaly of the net and its GPS position. | N ° net damages | PE |
| **Device for predators' detection** - like an electronic ear, it is able to identify the presence of a predator around the plant and to give an alert to the Plant Manager in order to perform the removal activities. | N ° predators alarms | P |
| **Device for solid waste recovery** - it is a collector that will be positioned at the bottom of the cage net. The waste particles accumulated by gravity, are periodically removed through a flexible tube connected with a dewatering system. | Kg of recovered solid waste | PE |

However, in order to better fulfil the central research question, other information about the product was considered for each category: i) Product: commercial denomination, scientific name, production method, FAO code, nutritional values, presentation, state of transformation, freshness, destination and the codes required by European standards, Batch number, operator names, dates of sowing and fishing, Type and amount of feed used, Curiosity about the product; ii) Company: country of production, company demographic information; iii) Production environment: breeding habitat description.
The production process, using S.E.A. devices, was modelled in order to demonstrate how collect traceability information about food as shown in **Figure *1***, where the dark grey activities are those supported by the proposed system. Downstream the process modelling, it made possible to identify for each activity the data relevant for traceability of farmed product. **Table *2*** summarizes for each activity, the mapped information, the source of the data and the collection method used (manual data entry or automatically data entry). A module of IT platform, dedicated to traceability, was developed in order to allow manual data entry of the missing information.

## 4. Conclusion and follow-up

From European and worldwide scenario arose as Aquaculture Industry has the potential to grow in the next years, in order to satisfy the global fish demand. At the same time, plant innovation could take into account environmental and ethical impacts of production and the increasing care of the consumer in health and wellness, that ask more information about food product. The S.E.A. project proposed a system composed by several IoT devices and an IT platform able to manage plant information, in order to assure an innovative and sustainable approach in aquaculture plant management. This information can be used for traceability purpose in order to demonstrate to final consumer the food quality and safety. Using the S.E.A. system and the traceability approach the company could increase: i) environmental sustainability, allowing to monitor environmental impact coming from the production; ii) economical sustainability, allowing to produce a quality product for higher market segment; iii) ethical sustainability, allowing to be transparent for the consumer. To date, the system satisfies the food traceability demand of the consumers through data collected automatically by S.E.A. devices and some data manually inserted by the operator in a dedicated module of the IT Platform. In order to improve it and take advantage of the related benefits, next step is the finalization of the traceability information by an innovative and automatically way to collect information actually inserted by manual data entry and to provide to the customer the visualization of the tracking data via the QR code, using the smartphone.

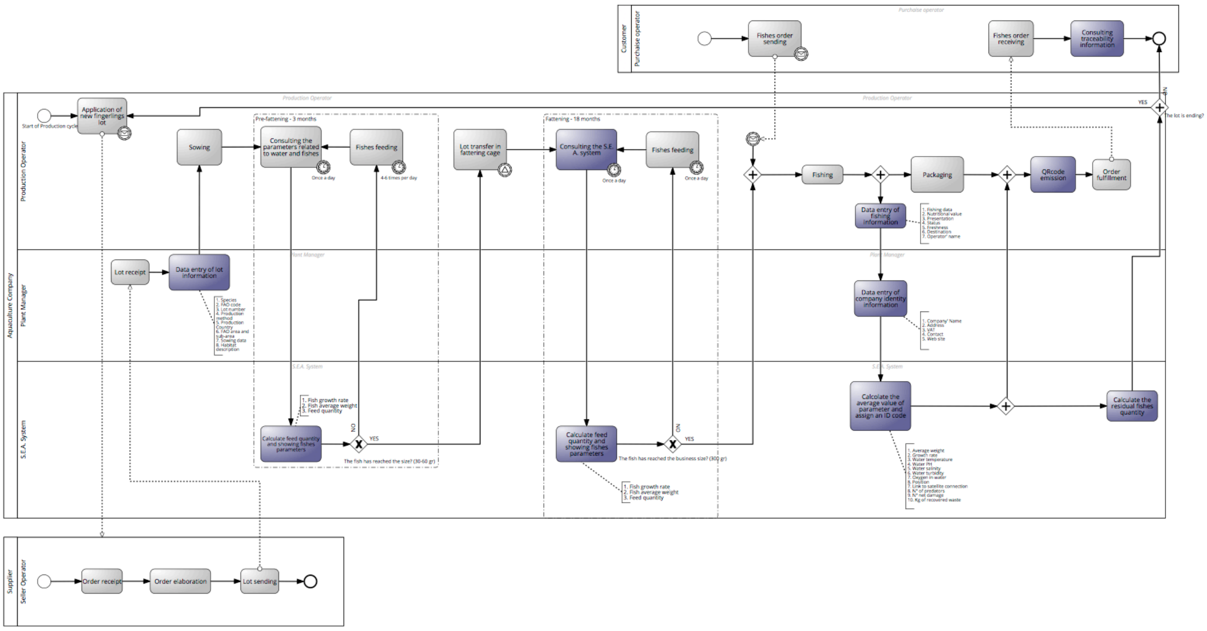


**Figure 1.** Production process using SEA devices modelled.

**Table 2.** All traceability information mapped in the activities within the new Production Process.

| *Activities* | *Data* | *Data source* | *Collection methods* |
|---|---|---|---|
| **Data entry of lot information** | Species, FAO code, lot number, production method, production country, FAO area and sub-area, sowing date, habitat description. | Plant Manager | Manual data entry |
| **Calculate feed quantity and showing fishes parameters** | Fish growth rate, fish average weight, feed quantity. | S.E.A. System | Automatically data entry |
| **Calculate feed quantity and showing fishes parameters** | Fish growth rate, fish average weight, feed quantity. | Plant Manager | Manual data entry |
| **Data entry of fishing information** | Fishing date, nutritional values, presentation, status, freshness, destination, operator' name | Production Operator | Manual data entry |
| **Data entry of company identity information** | Company' name, address, VAT, contact, website. | Plant Manager | Manual data entry |
| **Calculate the average value of parameter and assign an ID code** | Average weight, growth rate, water temperature, water PH, water salinity, water turbidity, oxygen in water, position, link to satellite connection, n° of predators, n° net damage, kg of recovered waste. | S.E.A. System | Automatically data entry |

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