

4H ICT, IoT Utilization in Fishing Port Operation

1 Introduction

1.1 Advances in ICT and IoT

The Third Industrial Revolution or Digital Revolution refers to the technological progress from analogue circuits and mechanical devices to the digital technology we use today. This period began in the 1980s and is still ongoing. In the late 1990s and 2000s, the Information Technology (IT), with its high performance and low cost of computers and high capacity and speed of communications such as the Internet, contributed greatly to the efficiency and globalisation of transactions. In the 2010s, IT has shifted to the Information and Communication Technology (ICT), emphasizing the importance of communication technology between people and between people and things, and the sharing of information and knowledge through network communication. ICT includes not only traditional communication devices such as PCs and smartphones, but also the Internet of Things (IoT) and the use of big data. Advances in the Third Industrial Revolution have made human intellectual work more efficient.

The Fourth Industrial Revolution is characterised by emerging technological innovations in areas as diverse as robotics, AI, nanotechnology, biotechnology, quantum computing, IoT, 3D printing and virtual reality. In recent years, the widespread use of the Internet and high-speed communications in all areas of the industry, society and life has led to the connection of people through PCs, smartphones and tablets, and also to the connection of things through the IoT. In addition, services with a variety of applications are becoming more readily available. In particular, developments in robotics and AI technology have the potential to change the way we work. The Digital transformation (DX)*, the concept that digitization changes social life, the economy and business for the better, is being promoted.

*DX is the process of using digital technologies such as ICT to create new - or modify existing - business processes, culture, to improve efficiency, value or innovation and meet changing business and market requirements in the digital age is digital transformation.

1.2 Objectives and effects of ICT and IoT utilization

Electronic auctions have long been widespread in fishing port markets, and online auctions are now available from anywhere in the world, without the need to visit the market. The website of the fishing port provides not only information about the auction, but also about the restaurants in the port and its surroundings. Good information spreads quickly through social networks. The number of personnel at the auction hall is also decreasing. There are PCs in the administration office, and communication with buyers and masters or owners of fishing boats is done via the internet rather than by telephone. Automatic sorting and grading machines are used for certain species of fish, as it is difficult to sort and grade fish manually. ICT, IoT utilization refers to the computerization of information from paper form to electronic form and the internet of people and things. In this way, ICT, IoT utilization can be seen in the operation of fishing ports, and the use also seems to be reaping the benefits of these technologies.

The followings are the objectives and effects for which ICT and IoT are used so that fishing ports can fulfil their roles and functions properly:

1 Ensuring transparency, parity and fairness;

Dissemination of information via the internet & website, etc.

2 Efficiency in sales operations;

Weighing scale, sorting & grading machine, electronic auction, etc.

3 Maintaining and increasing sales;

Greater participation of buyers, including from outside the local, through electronic and online auction

4 Ensuring safety and quality;

Labelling, electronic record for the HACCP system, etc.

5 Ensuring resource management;

Electronic recording and reporting catch and sales information, etc.

6 Ensuring traceability and sustainability;

Electronic issue of invoices and labelling, etc.

7 Improving safety of navigation and fishing operation; and

Electronic information, etc.

8 Efficiency in financial management, etc.

Electronic record

9 Enhancement of regional tourism centred on a fishing port

Dissemination of information via the internet & website, etc.

2 Dissemination of information via the internet & website

A fishing port is the base of the fishing industry, where the catch is landed and sold, and where processing and distribution are concentrated. A fishing port is where yachts and boats are moored and where seafood restaurants and hotels are lined up along the seaside. People involved in the fishing industry, as well as tourists and the general public, want to be able to access information about the fisheries, the fishing industry and the fishing port. On the other hand, the administrator and operator of the fishing port and market are required to ensure transparency, fairness and equity in their administrations and operations. These imply the importance and necessity of disclosure and provision of information.

2.1 Internet & website

As a method of disclosure and provision of information, it is appropriate to make use of ICT, which is widely used in industry and daily life. The administrator and operator use the internet to set up a website, post information on the website, and make the information available to users. Confidential information, which is inappropriate for disclosure and which identifies the user, can be made accessible only to users who registered in advance and enter your ID and password in the dedicated login.

2.2 Contents of information

The information provided on this site is broadly classified into the following categories: information about the Port Authority, information about the fishing port, information about the fishing industry, information about the market, information about safety and quality of fish and fishery products and other useful information. The users of the information include the general public who visit fishing ports for tourism and leisure, as well as fishermen, buyers and other traders, processors, transporters and suppliers of ice and oil. Depending on the nature of the information provided, the users of that information also differ.

In the case of a port authority setting up a website, the following is a list of appropriate contents of the information:

1 Port administration's information;

- Mission
- Organization (Organizational structure, board members, staff)
- Documents (Annual financial plan and report)

2 Port information;

- Roles or functions (Roles or functions of port and market)
- History (History, development of port)
- Port areas (Fishing port, marina, commercial port, etc.)
- Layout of port facilities (Breakwaters, quays, waterways, basins, handling hall, auction hall, administration office, freezing and refrigeration facilities, buyer's warehouses, parking lots, fishing

vessel building and repair yard, fishing gear drying ground, processing factories, logistic terminal, etc.)

- Hinterland (Fishing communities or town)
- Port services (Landing fish, idling vessels and preparing for fishing, cranes and hosts for fish landing, fishing vessel building and repair yard (shiplift, slipway, dry dock), ice supply, water supply and fueling, landing and collecting fish boxes, fuelling facilities, etc.)
- Rules for use of port facilities and services
- Aquaculture (Aquaculture, propagation, fattening or adjustment for sale of fish, shellfish and seaweed in water or on land in the fishing port)
- Tourism and local resources (Tourist attractions, direct-sales depot, restaurants, hotels, fishery experience spot, festival, fishing tourism, "pesca turismo", leisure boats, beaches)

3 Fisheries information;

- Types of fisheries (Fixed-net fishery, purse sein fishery, trawl net fishery, etc.)
- Home and foreign fleet (Overhaul length, horsepower, gross tonnage, types of fisheries, fishing grounds, etc.)
- Fish and fishery products (Fish caught, landed or unloaded, auctioned, processed fishery products)
- Fishery product processing and marketing

4 Sales information;

- Collection of landings (i.e. landing station or landing point)
- Auction (How the auction works, landing times, auction days/times).
- Fishermen (Register (ID and password), How you can provide landings information. fees and charges, rules and forms)
- Buyers (Register (ID and password), How you can buy fish at the auction. fees and charges, rules and forms)
- Expected landings (Catch method, species, grade, MSC certified, volume (number of boxes), download or print out of PDF, Excel file or CSV file)
- Today's sales catalogue (Fishing boat's name or number, catch method, species, grade, volume (number of boxes), download or print out of PDF, Excel file or CSV file)
- Prices (Sales date, fishing vessel, species, grade, MSC certified, volume (number of boxes), maximum prices, average prices, download or print out of PDF, Excel file or CSV file)
- Services (Sorting, grading and weighing, ice supply, clean water supply, fish boxes, packing and shipping purchased fish and fishery products)
- Documents (Invoices, landing statements, etc.)

5 Safety and quality of fish and fishery products;

- Quality management
- HACCP system (Videos and photos)

6 Fish resource management;

7 Sustainability;

- Status of Ecolabel certification
- Sales of Ecolabel certified fish

8 Fisheries statistics;

- Weekly, monthly and yearly landings
- Download or print out of PDF, Excel file or CSV file

9 News & topics;

10 Practical information; and

- Meteorological and oceanographic information
- Traffic information

11 Contact.

Figure 2.1 shows an example of the website set up by the port authority.

The image displays a screenshot of the Puerto de Vigo website. At the top, there is a header with the port's logo, 'E-GOVERNMENT SITE ACCESS', social media icons, and a search bar. Below this is a navigation menu with categories: Port Authority, Commercial Port, Fishing Port, Port and City, and Green Port. The main content area features a large aerial image of the port and a sidebar menu for 'Port and City / Tides and Meteo' with links to Port History, Port Archive, Port Images, Cruises, Visits, Tides and Meteo, Events, and Citizens Advice service. The main content area is divided into sections for 'Fishing Port / Infrastructure' and 'Fishing Facilities', with the latter containing detailed text about various auction types (Deep sea, Big fish, Coastal, and Literal) and their processes. To the right, there are several line graphs showing tide and meteorological data for the port. Below the main content, there are four columns of links corresponding to the navigation menu items: Port Authority, Commercial Port, Fishing Port, and Green Port. Each column lists relevant sub-topics and services.

Port Authority

- [President's Welcome](#)
- [Alerta Coronavirus](#)
- [Organization Chart](#)
- [Infrastructures](#)
- [Port Planning](#)
- [Quality](#)
- [Land Offer and Available Premises](#)
- [Plisan](#)
- [Blue Growth](#)
- [Work with us](#)
- [Publications](#)
- [Electronic Office](#)
- [Access Control Points](#)
- [Code of Ethics](#)
- [Notice Board](#)
- [News](#)
- [Contact](#)

Commercial Port

- [Introduction](#)
- [Huelga Estiba](#)
- [Port Today](#)
- [Statistics](#)
- [Regular Lines](#)
- [Port Services](#)
- [Commercial Services](#)
- [Port tax, Fees and Charges](#)
- [Railway Intermodality](#)
- [Security](#)
- [Census](#)
- [Applications and Authorizations](#)
- [Port Regulations](#)
- [PIF](#)
- [Port Community Directory](#)
- [Contact](#)

Fishing Port

- [Introduction](#)
- [Previsión de buques pesqueros](#)
- [The Fish Auction Today](#)
- [Infraestructure](#)
- [Lonja 4.0](#)
- [Statistics](#)
- [User Specifications](#)
- [Activity](#)
- [Servicio Eviscerado Grandes](#)
- [Peces](#)
- [Contact](#)
- [Introduction](#)

Green Port

- [Integrated Mangement Policy](#)
- [Tasks and Functions of the Department](#)
- [Facilities and Material Resources](#)
- [Innovation and Environmental Improvement](#)
- [Environmental Statement / Sustainability Report](#)
- [Environmental Guides and Instructions](#)
- [Documents and Plans](#)
- [Green Energy Ports Conference](#)

Port and City

- [Port History](#)
- [Port Archive](#)
- [Port Images](#)
- [Cruises](#)
- [Visits](#)
- [Tides and Meteo](#)
- [Events](#)
- [Citizens Advice service](#)

Source: <https://www.apvigo.es/en/paginas/inicio>

Figure 2.1 Websites and sitemap, Vigo, Spain

3 ICT, IoT-utilized sales

3.1 Recording, reporting and transmitting information on the catch and trade

Figure 3.1 shows the EU and US system for recording, reporting and transmitting information on the catch and trade of fish and fishery products to ensure fisheries resource management. An auction hall located at a fishing port is the first sale point where fish and fishery products received from producers are sold to buyers (processors or distributors), and is the only place (database) where catch and sale information can be accurately recorded.

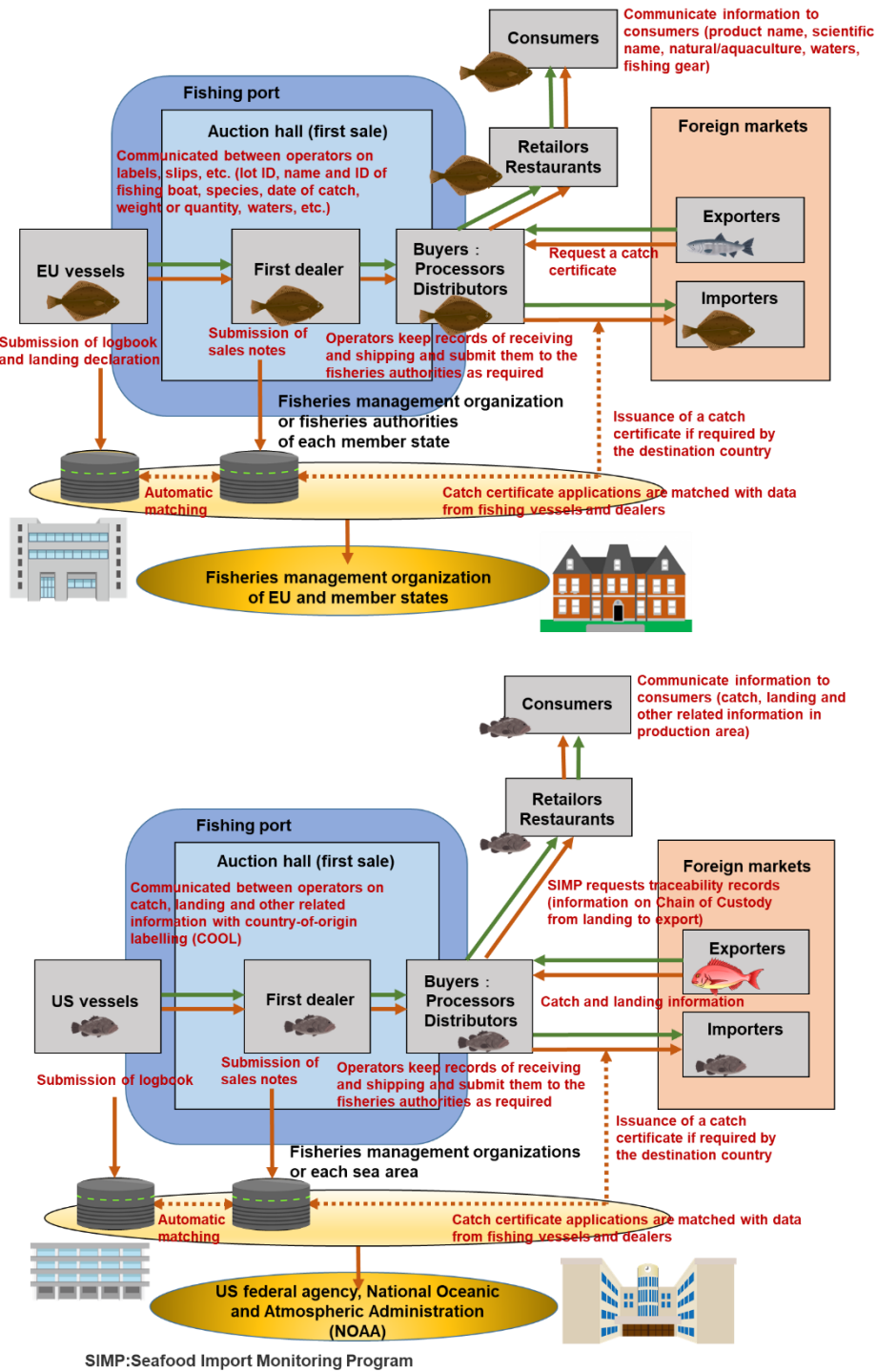


Figure 3.1 EU and US system for recording, reporting and transmitting information on the catch and trade

Figure 3.2 shows how ICT and IoT are utilized in the EU system. ICT, IoT utilization in sales means not only the electronic auction, but also the entire process of reporting catch information to the fisheries authorities and providing it to the market, landing at the fishing port and bringing it into the market, washing, sorting & grading, weighing, auctioning, delivery, shipping, issuing invoices (landing statements) to producers and bills (sales notices) to buyers, and reporting the results of sales (sales notes) to the fisheries authorities (or fisheries management organization).

The key to this computerization is a database in which the information on catch and sales is automatically recorded, through the electronic auction. Documents such as sales notices and the reports such as sales notes can be automated by pulling the necessary information from the database. The database can also facilitate the issuance of catch certificates and the provision of traceability information, which is necessary when exporting fish and fishery products, with a high degree of reliability and speed.

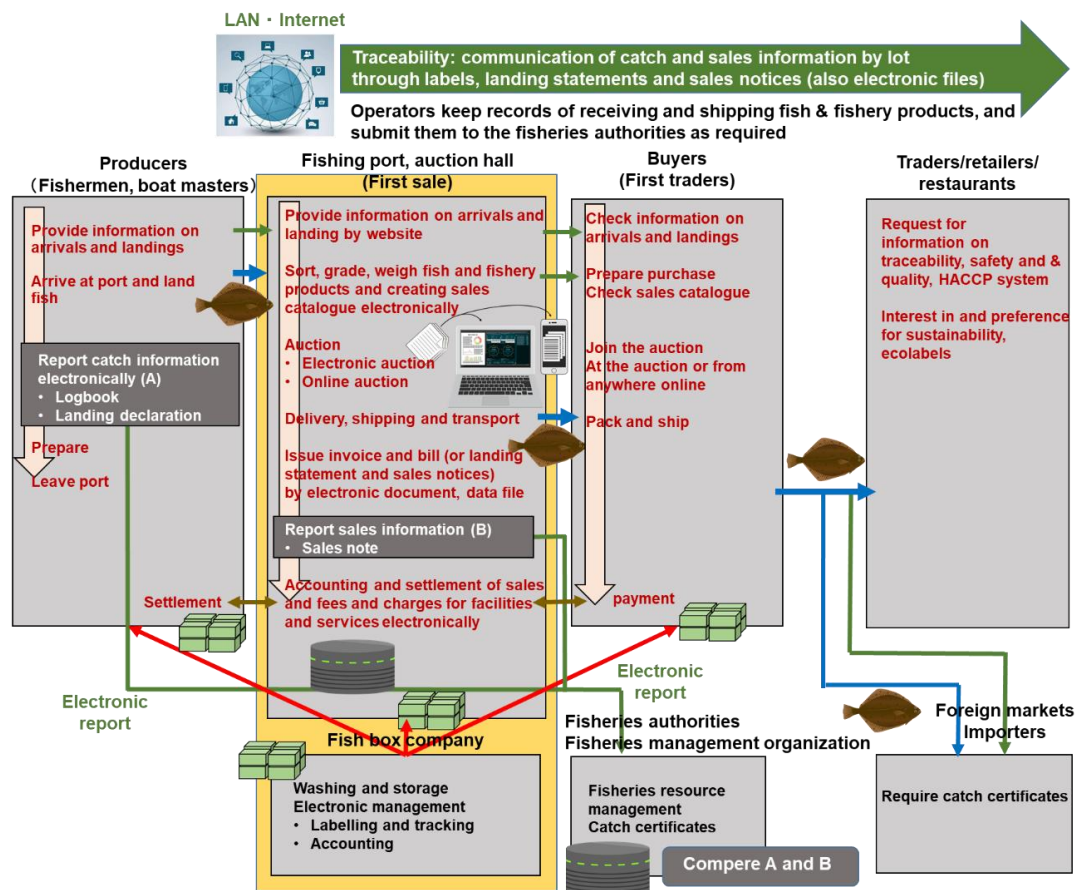


Figure 3.2 EU system utilizing ICT, IoT

3.2 ICT, IoT utilization according to sales process

3.2.1 Arrival of fishing vessels and landing information

Information on the date and time of arrival of fishing vessels and the landings is transmitted from the fishing vessels to the auction hall via the fishing vessel owner's office by telephone or internet the day before the sale or by the time of the auction. In some cases, reports to the fisheries authorities (or fisheries management organization) are also provided by the fishing vessels to the auction hall via the internet. Small fishing vessels operating day-trip coastal fishing catch a small quantity and variety of fish. So small fishing vessels are not required to provide landing information to the auction hall. However, when the fishing vessels they catch larger than usual, they provide landing information to the auction hall by mobile phone.

The fishing vessels arrival information includes the fishing vessel's name, the date and time of arrival, the expected date of sale, the species of fish and the number of fish boxes or the catch. Landing

information includes the name of the fishing vessel, species, grade, the number of fish boxes or the catch and also information on the species eligible for ecolabel fishery certification. This information is uploaded to the website, posted in the waiting & resting room for buyers, etc. of the auction hall. Figure 3.3 shows an example of providing arrival of fishing vessels and landing information on the website wet up by the Port Authority. Landing information is displayed by MSC certification status.



Source: <https://www.peterheadport.co.uk/>

Figure 3.3 Arrival of fishing vessels and landing information, Peterhead, UK

3.2.2 Landing and bringing in the auction hall

On the day before or on the day of the scheduled sale, the fish are removed from the hold in fish boxes using cranes on board or on the quay and brought in the main building of the auction hall on forklifts or trolleys. Floating fish (pelagic fish) are taken directly from the hold to the tanks on the quay or into the main building by fish pumps or nets. The fish boxes and tanks are placed in a cold controlled area soon after landing to ensure freshness.

Figure 3.4 shows the labels on the fish boxes landed at Lerwick and Scalloway. The fish has already been sorted and weighed on board before landing and includes information such as fishing vessel's name, species and weight by fish box.

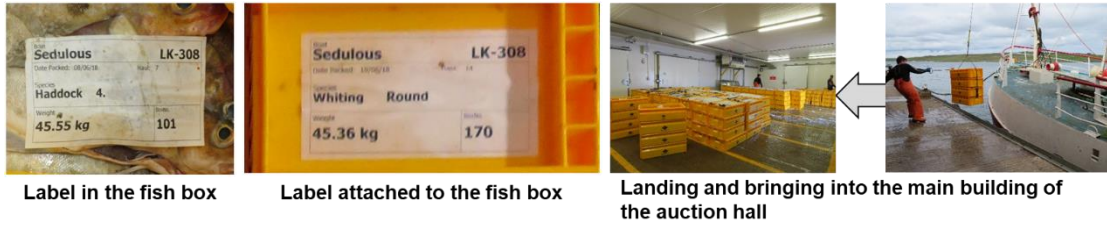


Figure 3.4 Labels attached to the fish boxes landed at the quays, Lerwick & scalloway, UK

3.2.3 Sorting, grading, weighing fish and creating sales catalogue

3.2.3.1 Sorting and grading

Catch may be sorted, graded and weighed on board (depending on the species, primary treatment such as gutting may be also carried out on board), and a label with their results (fishing vessel's name, catching area, species, grade, weight, etc.) attached to the fish box, as shown in Figure 3.4. The content of the label attached to the fish box is scanned and additional information such as the quality level added from a tablet/PC terminal. Even if fish are weighed in advance, the information on the label may be incorrect or the label may be unclear, and in order to ensure traceability with accurate information, fish are weighed on a sample basis by fishing boat, species and grade for check.

In the case where the catch has not been sorted, graded and weighed on board, the automatic fish species sorting machine may be used for horse mackerel and other species and the automatic fish grading machine may be used for flatfish, flounder, skipjack, salmon, etc.

Figure 3.5 shows the automatic grading machine at Scalloway, UK, and Figure 3.6 shows other examples.



Figure 3.5 Automatic grading machine for flatfish, Scalloway, UK



Grading machine for salmon
Ishinomaki, Japan

Grading machine for ??
Tarragona, Spain

Figure 3.6 Other examples of automatic grading machines

3.2.3.2 Weighing and creating sales catalogue before auction

The fish box with fish in is placed on the weighing terminal and the catch information such as the fishing vessel's name and number, start and end dates of catch, catch area, and fishing method is entered from the panel of the weighing terminal as shown in Figure 3.7. The information such as species, grade in

size, condition (fresh, frozen, etc.), quality level and eco-label certification (e.g. MSC certification) is also entered. The information is automatically sent to the server at the time of weighing, resulting in printing a label containing the information, which is posted on the side of the fish box or placed in the fish box. It is relatively easy to create a sales catalogue by drawing the necessary data from the server.

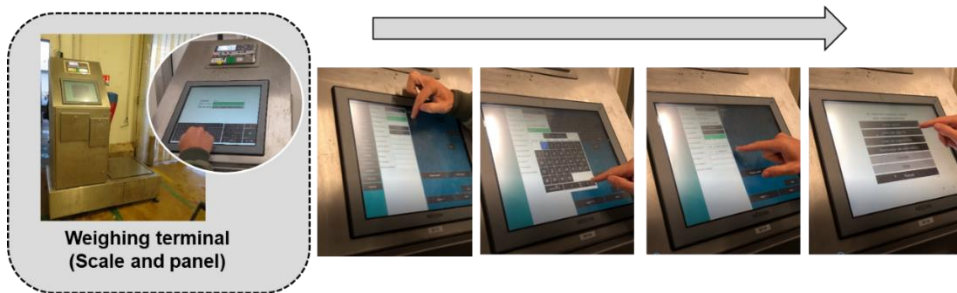


Figure 3.7 Weighing terminal, Boulogne-sur-Mer, France

The sales catalogue may be created by entering the information on the labels or slips (small sheets of paper) in the fish box from a tablet/PC terminal as shown in Figure 3.8. As most of the necessary information about the fish is defaulted, has to be actually entered from the weighing panel, or tablet/PC terminal. Sales catalogues are printed out and distributed to buyers, or pre-registered buyers can log in to the website to view, print out or download (as a PDF file).



Figure 3.8 Creating sales catalogue, Skagen, Denmark

Figure 3.9 shows the forklift with a tablet-mounted weighing scale and fish tanks with IC tags at Ofunato, Japan. RFID tags are attached to the fish tanks, one at the front and the other at the back of the tank. The weighing results by using a forklift weighing scale are linked to the tank number read from the RFID tag and sent to the server for recording. A tank of seawater or ice is pre-weighed and then the tank is weighed with the fish in it. By subtracting the weight of the former from that of the latter, the net weight of the fish is obtained.

Figure 3.9 shows other examples of weighing scales with ICT, IoT utilized.



Figure 3.9 Forklift with tablet-mounted weighing scale and fish tanks with IC tags, Ofunato, Japan

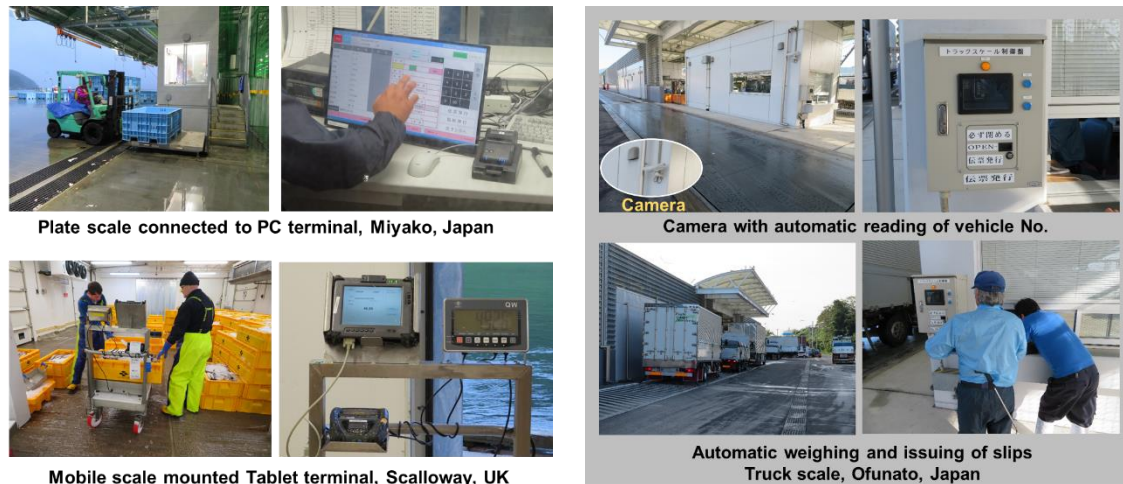


Figure 3.10 Other examples of weighing scales with ICT, IoT utilized

3.2.3.3 Weighing and creating sales catalogue in the course of auction

Fish boxes with fish in by fishing vessel are placed on the conveyor belt moving to the auction area. When the fish box reaches the scale on the conveyor belt, it is automatically weighed. Figure 3.11 shows the weighing and creating a sales catalogue at Lorient-Keroman, France. Market personnel enter the information about the fish other than the weight, resulting in creating a sales catalogue. The information for sale is shown on the screen or electronic display in the auction hall.

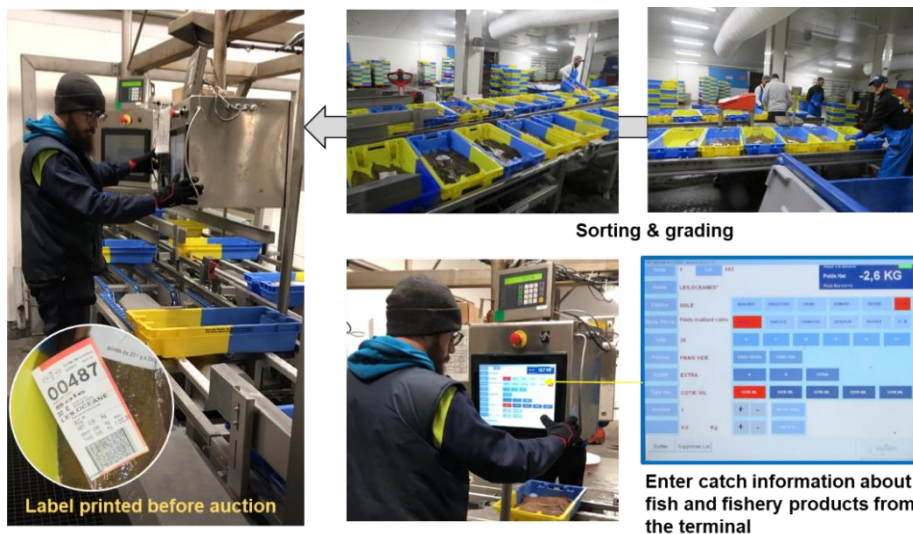


Figure 3.11 Weighing and creating a sales catalogue, Lorient-Koroman, France

Figure 3.12 shows the weighing and creating a sales catalogue while fish boxes with fish in are moving on the conveyer belt at Civitanova, Italy. In the cabin near the auctioneer, information such as the fishing vessel's name and number, catch area, species, grade in size, condition and quality level other than the weight are entered from a PC terminal, and a sales catalogue is created. The video footage of the fish and information for sale are shown on the screen in the auction hall. The auctioneer announces the quality of the fish to the cabin and the auction for each sales lot begins.

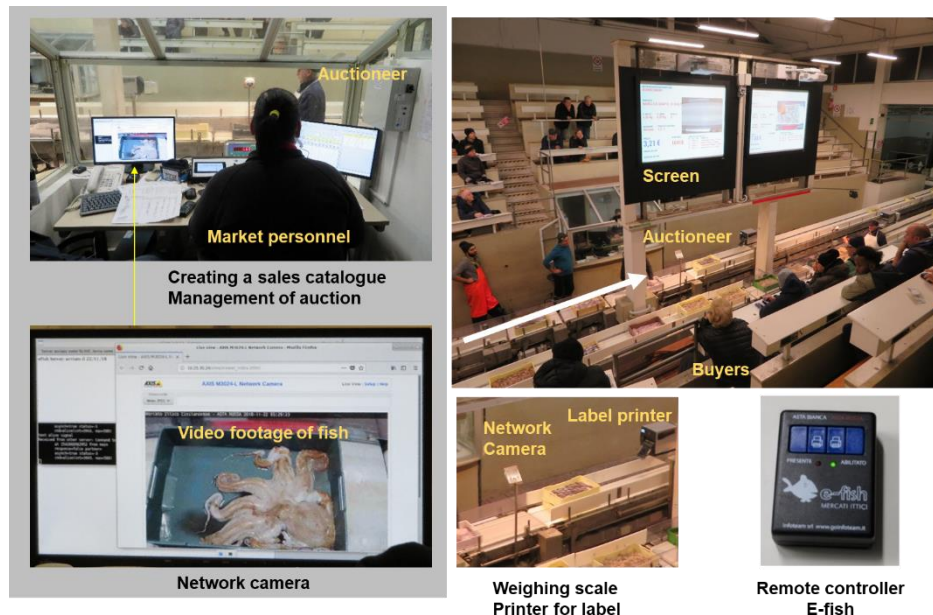


Figure 3.12 weighing and creating a sales catalogue while the products are moving on the conveyor belt, Civitanova, Italy

3.2.4 Auction

3.2.4.1 History of electronic auction

Electronic auction was first introduced in the late 1980s to save labour and time, improve efficiency and avoid manual errors. The system was based on the auction clocks already used in the flower markets at the time. In the 1990s, PCs became more sophisticated and network connections, such as LANs, were used for more sophisticated work. The opening of the Internet, developed in the United States, to the private sector accelerated informatization, and from the mid-1990s the Internet spread rapidly throughout the world, enabling the instantaneous and interactive exchange of a large amount of information. Moreover, the development and widespread use of mobile phones has made it possible to exchange information from any location. This has led to the introduction of online auctions, where buyers from all over the country and the rest of the world can participate via the internet. The number of markets conducting online auctions has increased since 2000 due to the widespread availability of broadband and also the increasing use of smartphones in the 2010s. A web-based transaction system has also been launched.

As buyers may participate in the auction from all over the world, it is a prerequisite that a quality assurance system for fish and a delivery system from the auction hall are in place. For the quality assurance system, there are EU quality criteria and more detailed criteria set up by Scandinavia and other exporting countries. As for the delivery system, it must be punctual and ensure a cold chain up to the buyer's designated destination. The Nordic and Scottish markets, such as Norway, Denmark, the Faroe Islands and Shetland (UK), meet these requirements, and rely heavily on online auctions.

3.2.4.2 Classification of auctions in terms of the utilization of ICT, IoT

Auction is a very old tradition of selling or buying of products and services which allows the highest bidder to get hold of them. Types of auction comprise a Dutch auction/descending-price auction, an

English auction/ascending-price auction, and a first-price sealed-bid auction/blind auction, as described in Chapter 4G.

According to the extent to which ICT, IoT is used for computerization, automation and systematization of the auctions, they are classified as follows:

1 Conventional auction/manual auction (local auction/physical attendance auction);

The auctioneer starts the auction with a shout in front of the fish. In the case of an ascending auction, the buyer voices the price or indicates it with his finger. In the case of a descending auction, the auctioneer shall state the price and the buyer shall respond to it by voicing or gesturing.

2 Electronic auction (local auction/physical attendance auction);

Computers have been introduced to automate and systematize the auctioneering process. The information about the fish is displayed on an "auction clock" - electronic board or screen - , and the buyers join the auction while looking at the fish. The buyer presses a key on a remote control or pad at the price he wants to buy. A computer network (LAN), has been set up, with wireless or wired connections between server, computers, remote controls and terminals. The information converted into database as the auction progresses would contribute to the automation and efficiency of the work that follows the auction, such as the issuance of invoices and sales notices.

3 Electronic auction (Online auction/internet auction/remote auction);

By connecting the auction hall's computer network (LAN) to the internet, it is possible to participate in the auction in real time from anywhere in the world, without having to go to the auction hall (not physical attendance), as far as buyers have PCs, tablets or smartphones with an internet connection. It is also possible to participate in more than one auction or market simultaneously. This would lead to the more new buyers.

4 Electronic auction at the virtual market (first-price sealed-bid auction online); and

The virtual market is built in cyberspace and first-price sealed-bid auctions online take place. In the virtual market, the market in cyberspace, the producers (fishing vessels) at sea and buyers (processors) around the world are linked via the internet, and once each auction is completed, the fishing vessel goes directly from the fishing grounds to the processing plant designated by the buyer. In addition to the benefits of electronic auction, the separation of sales and logistics saves labor and time, and contributes to keep the catch fresh. On the other hand, it is noted that it is difficult to find a link with the function of fishing ports.

5 Web transaction/negotiated transaction.

Via the internet, sellers and buyers negotiate with each other on the web and decide on items, prices and quantities in advance or at the auction.

With the utilization of ICT, IoT, auctions are held in different locations - display area, auction area, auction room, anywhere inside and outside the auction hall, virtual market - as described in Chapter 4G.

3.2.4.3 Examples of classified auctions

(Input of auction results into electronic sales catalogue)

Figure 3.13 shows the ascending-price oral auction in the display and auction area at Hanstholm, Denmark. The auctioneer, accompanying two recorders, conducts the auction. Two recorders are assigned to double-check the results in order to avoid errors in listening and inputting.

The auctioneer states the prices and then buyers respond to it by voicing or gesturing. Soon after auctioned off by lot, the recorders enter the results of the auction on the sales catalogue from the PC terminals and when both records match, sales information is automatically sent to the server and recorded. The winning buyer put his paper nameplates in the fish box. The market personnel scan the barcodes of the labels attached to the fish boxes for tracking fish boxes.

The status of the auction is projected on the wall in real time. The species of fish, quality level, grade in size, quantity, unit price and the winning buyer's name of each lot by fishing vessel are displayed.

Figure 3.14 shows another example of auction at Minami-sanriku, Japan.



Figure 3.13 Ascending-price oral auction in the display area, Hanstholm, Denmark



Figure 3.14 Another example of auction, Minami-sanriku, Japan

(Electronic auction local and online – auction leans, screen, video footage)

Figure 3.15 shows the electronic auction local and online in the auction area at Lorient-Keroman, France. Two auctions with two lanes are carried out while fish boxes with coastal fish in (one box is one lot) are moving on the conveyor belt by fishing vessel. One screen displays the lot number, fishing vessel's name, species, grade in size, conditions (frozen, fresh, etc.), weight and the other one shows video

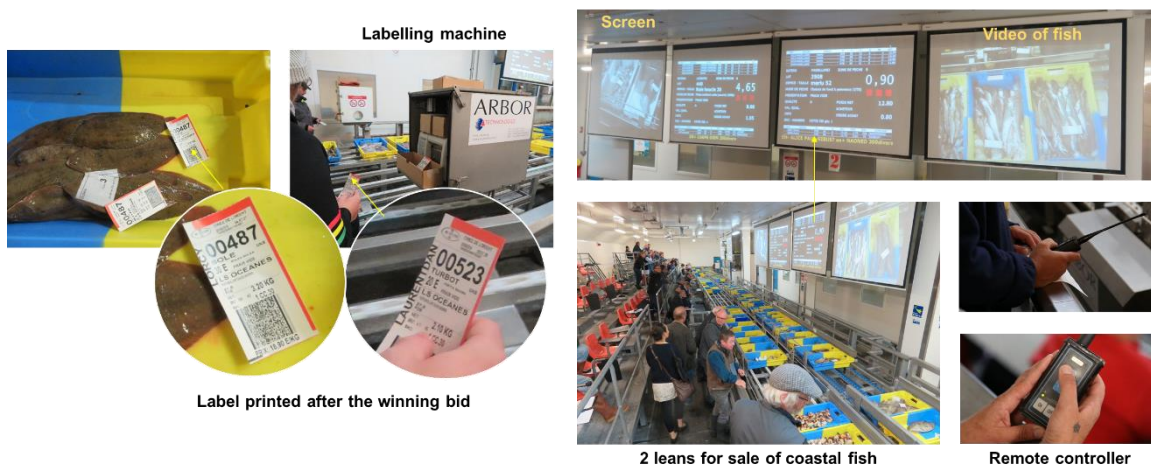


Figure 3.15 Electronic auction local and online in the auction area, Lorient-Keroman, France

footage of the fish in the fish box. The price descends at a constant rate, and when the price you want to purchase is reached, you press the remote controller. The first buyer to press the remote controller becomes the winner.

During the auction process, two labels are placed on the fish box with the fish in. One label is printed and put in the fish box after the weighing and the other is done in after the winning bid. The latter label has the name of the winning buyer and the unit price which are added to the content of the former label. The label also contains a QR code, which can be read with a mobile phone for traceability purposes.

Online auctions at Lorient were introduced in 2000 and the average price has been rising ever since. In 2008, a system was introduced to take video footage of the fish in the fish box for sale and distribute them in real time, so as to facilitate buyers to participate in the auction and purchase online.

Figure 3.16 shows other examples of electronic auction local and online in the auction area.



Figure 3.16 Other examples of electronic auction local and online in the auction area

(Electronic auction local and online – mobile electronic board bike)

Figure 3.17 shows the electronic auction local and online in the display at Concarneau, France. Two auctions at the same time are carried out using a mobile electronic board bike, moby-clock, operated by one person. The price descends at a constant rate, and when the price you want to purchase is reached, you press the remote controller. If there is more than one person, the price goes up and the person who keeps pressing the remote until the end will be the winner. The results of the auction are printed on a label from a printer mounted on the moby-clock, and then the label is put in the fish box.

The current system introduced 20 years ago has saved the market personnel’s labour and time, and contributed to the fairness, parity and transparency of the auction.



Figure 3.17 Electronic auction local and online in the display area, Concarneau, France

(Connected auctions in markets)

Figure 3.18 shows the connected auctions in the markets across regions and countries, where Pan European Fish Auctions (Pefa) Online Trading System (herein after referred to as 'Pefa system') is

employed. The auctioneer conducts the electronic auction (local and online) in the auction room or administration office. Buyers join the auction in the auction room or online from home and abroad.

Buyers can download the Pefa app to pre-register and use the app to join the any auction in the markets employing Pefa system.



Photo upper: <https://denhaag.com/nl/visafslag-scheveningen>

Figure 3.18 Connected auctions in markets across regions and countries, by the same online auction system

(Integrated markets)

Figure 3.19 shows an example of integrated markets in Denmark. Danske Fiskeauktioner A/S has operated markets in the three West Coast ports of Thyborøn, Hvide Sande and Thorsminde since 2008, moving from conventional outcry auction to electronic auction by employing the Pefa system, with each market integrated through the internet in order to save market personnel' labour and time and enhance competitiveness under fisheries resource management.



Figure 3.19 Integrated markets nearby fishing ports, Denmark, by the same operator and the same online auction system

Fish are landed at the various fishing ports and information on the landings is collected in Thyborøn, where a sales catalogue is produced. The fish are sold centrally in Thyborøn. After electronic sales, the fish are dispatched from the markets. This is a sort of separation of sales and logistics, made possible through the utilization of ICT.

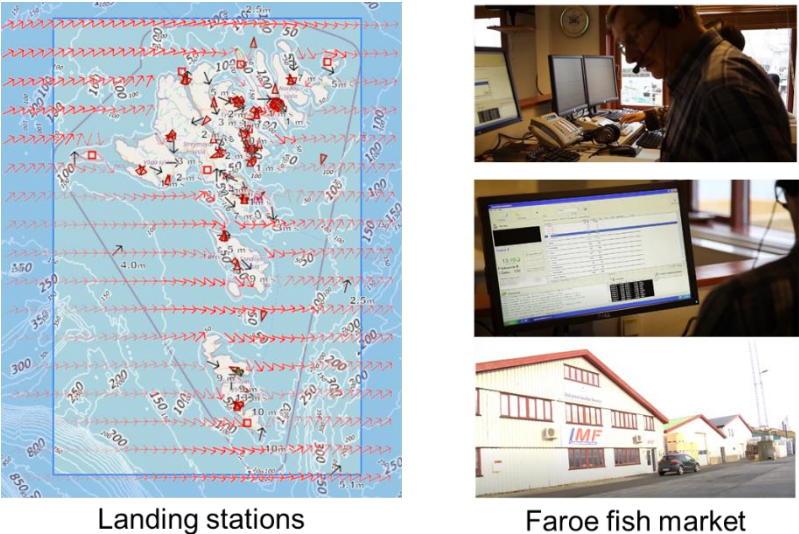
(Virtual market)

Figure 3.20 shows another example of the virtual market, Faroe Fish Market in the Faroe Islands. Faroe Fish Market is situated in Toftir where all the sales are completed. However, it is up to the producer (fishing vessel) where he/she wishes to land the fish. Faroe Fish Market is not landing any fish and leaves all the fish handling in the landing stations.

While the boats are still out at sea, they report the information on their catch to the auctioneer for so including landing location. Faro Fish Market then informs the buyers of the estimated quality and size of each type of fish when, where and how the fish was caught and how the fish is kept. The seller is able to request a minimum price for each type and size of the fish to be sold. The catch is advertised in Faro Fish Market’s website where the buyers can plan ahead for what they want to buy for production or for exportation.

The auctioneer sets the starting price and the bidding intervals of the auction. The system starts with a high price and then goes downwards until a buyer presses the button. Now the price stops for a few seconds and if other buyers join the auction, the price will go upwards until the highest is found. The buyer will then tell the auctioneer via telephone when he wants to buy it. The fish purchased are dispatched from the landing stations to the processing factories in the islands or exported.

After the auction, the buyers can get a detailed overview of what is bought, which fishing vessel it is from and where the fish is landed. The invoices from the fish market are sent via email as electronic documents that are easily imported into the buyer’s production system. This is a sort of separation of sales and logistics, made possible through the utilization of ICT.



<https://mfm.fj/english/>, <https://www.youtube.com/watch?v=orjqgkBzyaw&t=149s>

Figure 3.20 Virtual market, Faroe Fish Market, the Faroe Islands

3.2.5 Delivery, dispatch and transport

The fish auctioned off are checked by the market personnel for the contents of the labels in or on the fish boxes and are placed together in the designated area for each buyer, who has purchased them, where the fish are delivered from the market to the buyers. Then the fish are either dispatched from the auction hall by truck, carts or forklift as they are or, after packed.

The label contains catch and sales information that identifies the fish by lot, which is also necessary information to ensure traceability. Traceability information can be obtained in a variety of formats (PDF, Excel and CSV files) by reading it with a smartphone or other device from the barcode or QR code on the label on the fish box.

Figure 3.21 and 3.22 show the labels and the information contained therein in or on the fish boxes at Giulianova, Italy, and at Gilleleje, Denmark respectively.



Figure 3.21 Delivery of fish with a label in the fish box, Giulianova, Italy

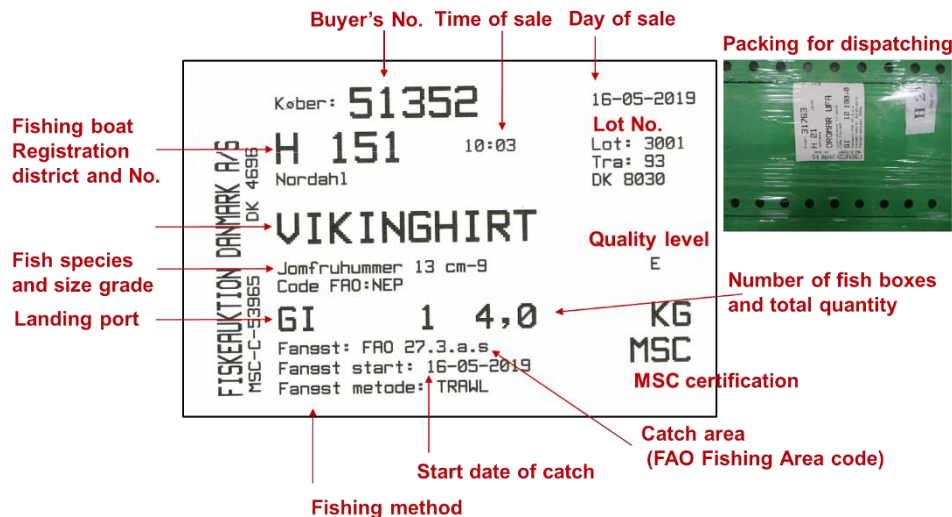


Figure 3.22 Delivery of fish fishery products with a label in the box, Gilleleje, Denmark

3.2.6 Issuing landing statements and sales notices

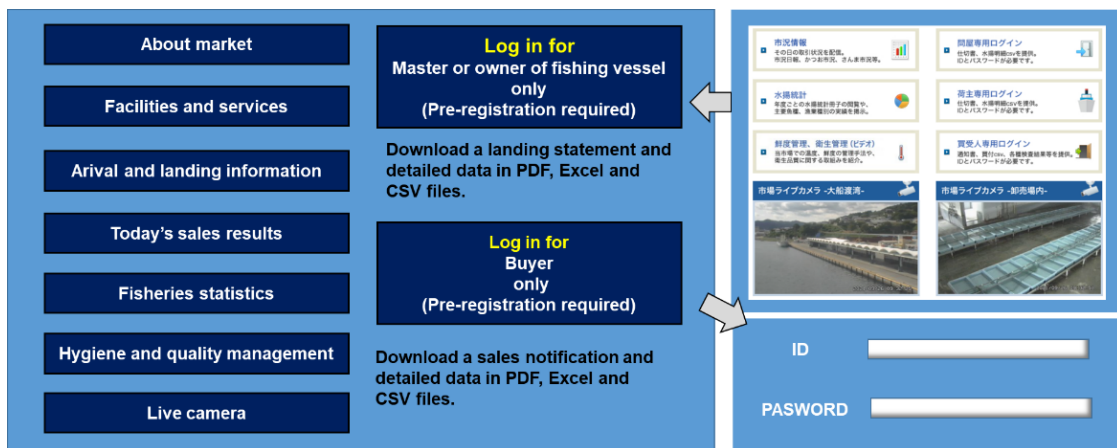
Information on the catch and sale is recorded electronically on the auction hall's server through the sales process. After the day's sales, landing statements to producers and sales notices (invoices) to buyers are automatically created by drawing necessary information from the server. A landing statement is a vessel-by-vessel list of which fish and have been purchased and by whom. A sales notice (invoice) is a bill for the fish purchased by the buyer.

Fishing vessel's owners or buyers receive these documents manually or electronically as follows:

- The market personnel print out the documents on paper and post them in the boxes of the buyers and the fishing vessel's owners respectively;
- The personnel send the PDF file or other type of file to the buyers and the fishing vessel's owners by email; and
- Buyers and fishing vessel's owners log in the dedicated website to view and download them and detailed data in PDF, Excel and CSV files.

The day's sales results (fish species, grades, quality levels, prices, etc.) are uploaded on the website, soon after the auction.

The landing statements and sales notices contain catch and sales information that identifies fish, and these documents can be recorded electronically by the vessel owners, buyers and market personnel to ensure traceability. Statistical information on the volume and value of sales by fish species and fishing method is reported monthly to the municipal and state statistical authorities and to the fisheries authorities. The accounting of commissions, charges, taxes associated with sales and other services is also computerized.



<http://www.ofunato-fm.com>

Figure 3.23 Website for download of landing statements and sales notices, Ofuna, Japan

Fisk	Klasse	Sortering	MSC	Kasser	Total kg.	Pris	Sælger
HAVTASKEH	A	3	Nej	2	40,00	81,50	F13904
Total for HAVTASKEHALE				2	40,00		
MØRKSEJ	E	1	Ja	1	33,00	14,50	S 43
MØRKSEJ	E	2	Nej	2	52,00	14,00	F14002
Total for MØRKSEJ				3	85,00		
RØDSPÆTT	E	0	Ja	8	253,00	22,00	FF
RØDSPÆTT	E	1	Ja	6	210,00	22,75	FF
Total for RØDSPÆTTE				14	463,00		
TORSK	E	0	Ja	1	11,00	47,00	S 43
TORSK	E	1	Ja	1	7,00	47,00	FF
TORSK	E	1	Ja	1	9,00	49,00	HM 289
TORSK	E	2	Ja	2	34,00	45,00	FF
TORSK	E	2	Ja	5	121,00	54,00	S 43
TORSK	E	2	Ja	5	100,00	44,50	HM 289
TORSK	E	3	Ja	5	116,00	41,00	S 43
TORSK	E	3	Ja	5	115,00	39,75	S 43
TORSK	E	3	Ja	4	98,00	38,25	S 43
TORSK	E	4	Ja	5	100,00	25,75	S 43
TORSK	E	4	Ja	12	240,00	25,75	S 43
TORSK	E	4	Ja	1	25,00	25,00	HM 289
Total for TORSK				47	976,00		
TOTAL				66	1.564,00		

Species	Sort	Kilos	Avg.	Max.	Currency
Catfishes	1	155,00	21,57	21,75	DKK
Catfishes	2	97,00	22,77	24,00	DKK
Catfishes	3	4,00	5,00	5,00	DKK
Saithe	3	1447,00	11,47	13,50	DKK
Saithe	4	1703,00	9,03	9,25	DKK
Witch Flounder	1	180,50	48,95	51,50	DKK
Witch Flounder	2	521,00	37,88	38,25	DKK
Witch Flounder	3	517,00	14,02	15,50	DKK

List of purchased fish and fishery products

Sales result

<http://www.hirfiskauk.dk/Prices>

Figure 3.24 Purchase list printed out and sales results on the website, Hirtshals, Denmark

Figure 3.23 shows the website where landing statements, sales notices and their detailed data in PDF, Excel and CSV files can be downloaded at Ofuna, Japan. Today's sales results, and fisheries statistics also be downloaded. Within an hour after the end of the day's sale, landing statements and sales notices are issued, followed by the sales results uploaded.

Figure 3.24 shows the purchase list printed out and sales results at Hirtshals, Denmark. There is a printer in the auction hall, and when a buyer puts his chip on the sensor, a list of fish purchased up until now is printed out.

3.3 Service charges

To ensure safety and quality of fish and safety and efficiency of operations for sale, clean seawater, tap water, ice and electricity are consumed, and machine and equipment such as electric forklifts, carts, and grading machine are used. Users shall be properly charged, in accordance with the rules. The more electronically the information on users' charges are recorded in real time, and invoices and bills are issued soon, the more efficient operations are carried out and the more labor and time are saved.

Figure 3.25 shows the management system for forklift use and its electricity charges at Ofuna, Japan. Each time a user charges a forklift, information on its use is automatically recorded on a server in the central computer room. Users other than market personnel are charged according to their use of the forklift and the electricity.

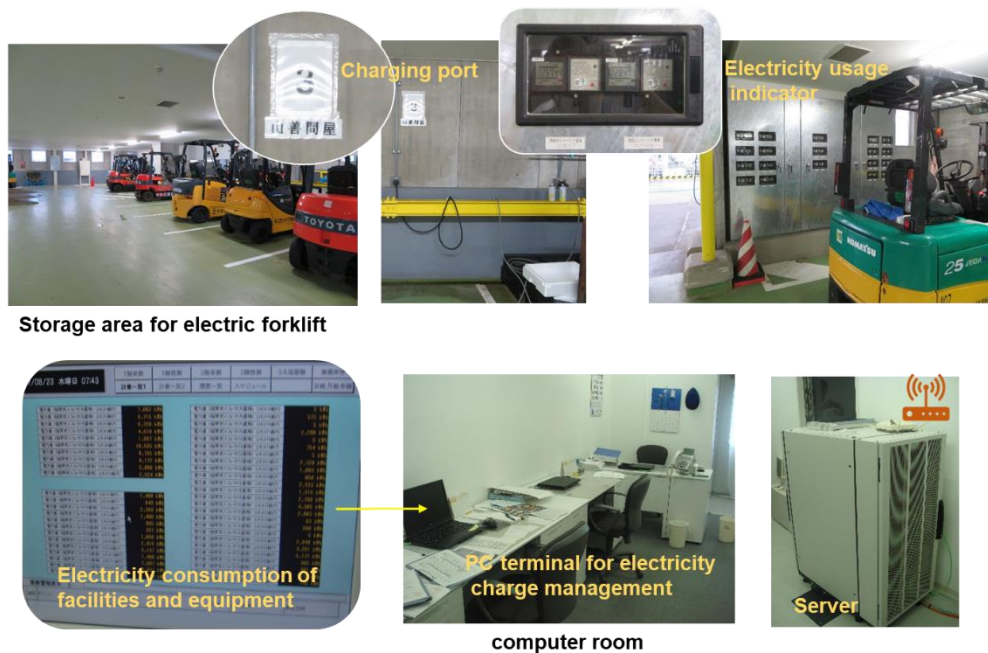


Fig.3.25 Management system for forklift use and its electricity charges, Ofuna, Japan

4 HACCP system facilitated by ICT

At the auction hall where fish and fishery products are sold, the HACCP system is applied for food safety. Specifically, the auction hall is required to maintain and improve its structures & facilities, and machinery & equipment as well as provide guidance to users and maintain records of the measures taken to control hazards as described in chapter 4G. As a part of the HACCP system, the person responsible draws up a management manual, which will be followed by the relevant personnel who will check the status of management at the control points and record the results in a record book (on paper generally). The person responsible finally confirms the results of the checks made by the personnel and keeps the record book.

Considering the limited number of personnel and their time, it is necessary to have a computerized system that can automatically manage the hygiene of people and vehicles entering and leaving the

auction hall and fishing port, and easily record the results of hygiene management and provide them quickly upon request. The utilization of ICT in the control of the entry and exit of people and vehicles, and in recording the check results at the control points, can save personnel and time for the HACCP management.

4.1 Automatic entry and exit management system

The automatic entry and exit management system for vehicles automatically authenticates the vehicle at the gate to ensure that it is a pre-registered vehicle, and also works in conjunction with the car wash facilities and gate operation to automatically control the hygiene and safety of vehicles entering the landing and clearance area. The vehicle can be identified either by contact, using an ID card, or non-contact, using an automatic reading of the vehicle number. The system eliminates the need of assigning the personnel to control whether vehicles are entering the auction hall properly, and ensures that the auction-related people (market personnel, buyers, distributors and transporters, etc.) comply with hygiene management for vehicle entry.

Figure 4.1 shows the example at Ishinomaki, Japan. Vehicle entry and exit facilities using contactless transit cards have been installed at the gate of the access road to the quay, allowing only authorised vehicles to enter. When a vehicle enters or exits the quay, the number on the vehicle's number plate is read at the gate, and if the vehicle is not registered, it is either not allowed to enter or is checked by the market personnel using a live camera, and if there is no problem, it is registered before being allowed to enter. There is also a car wash area at the entrance gate after passing through the gate, where water is sprayed in conjunction with the gate to wash tyres. At this time, video footage of the tyre washing process is recorded.

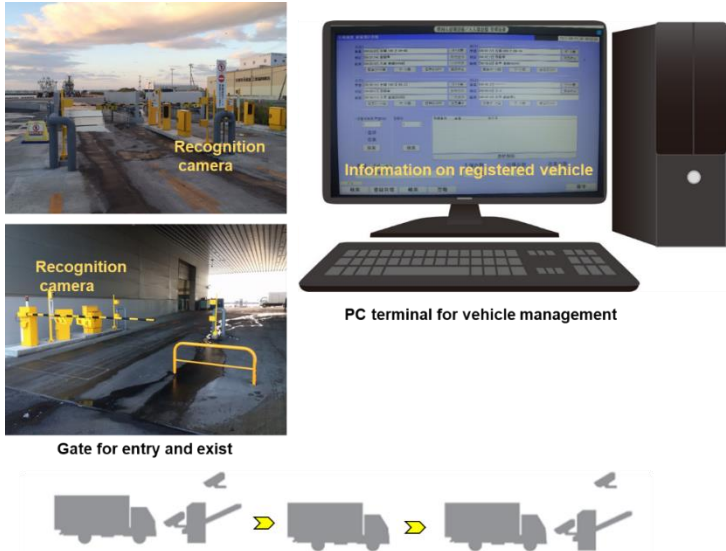


Figure 4.1 Automatic entry and exit management system for vehicles, Ishinomaki, Japan

The automatic entry and exit management system for people confirms that the person has been registered in advance and automatically carries out hygiene and safety control in the workplace by opening the entrance door to the workplace in conjunction with hand washing, hand disinfection, changing into boots and boot washing. There are two methods of automatic authentication: contact method using ID cards and non-contact method using automatic reading of ID cards (RFID).

Figure 4.2 shows the example at Ishinomaki, Japan. All those entering the auction hall are required to wash their hands, disinfect their hands and wash their boots in the access control room, and only those who are authorized by ID authentication are allowed to enter. The washing of hands and boots is recorded on video.

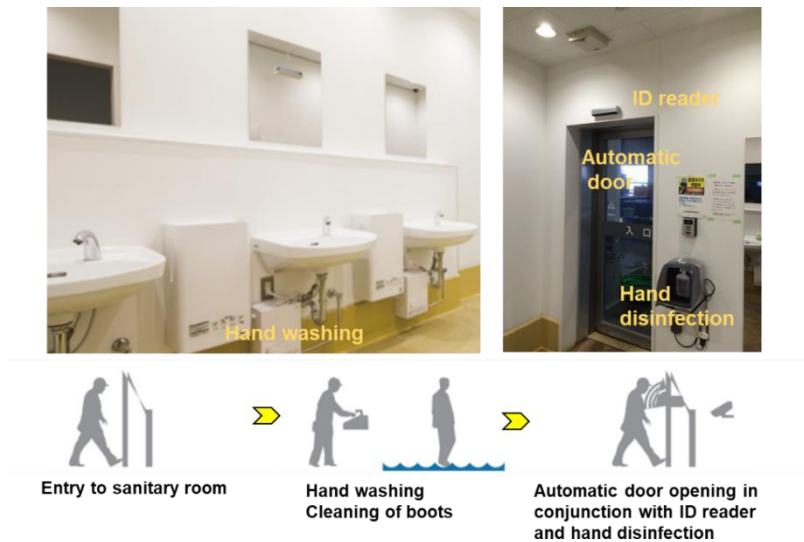


Figure 4.2 Automatic entry and exit management system for people, Ishinomaki, Japan

4.2 Camera system

By placing cameras at various locations in the fishing port, including inside and outside the auction hall, the use of the fishing port such as the arrival, landing, anchoring and preparation for departure of fishing boats, the sales situation in the market, as well as the hygiene management status can be centrally monitored, recorded in real time from a PC terminal in the office.

Figure 4.3 shows the centralized surveillance camera system at Akkeshi, Japan. Twenty three cameras are installed in the fishing port, and PC terminals in the administration office allows the port and market



Figure 4.3 Surveillance cameras installed throughout the fishing port, Akkeshi, Japan

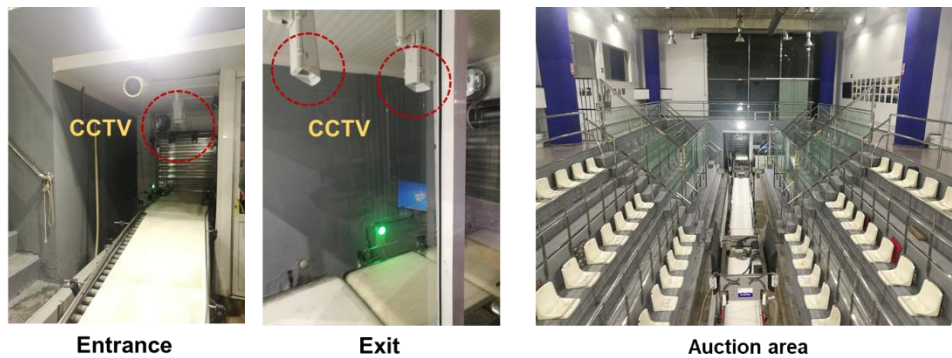


Figure 4.4 CCTV installed along the auction lean, Tarragona, Spain

personnel to view video footage in real time, as well as video footage automatically recorded on a server for the past two weeks. These images are used to check the entry of suspicious persons and non-authorized vehicles.

Figure 4.4 shows CCTV installed along the auction lean, Tarragona, Spain. Although there are differences in system structure and function between CCTV and surveillance cameras, both are installed and centrally controlled to monitor ports and check the safety of operations in markets and other areas.

4.3 Electronic recording for HACCP management

In accordance with the HACCP system, the relevant personnel check the hygiene management status at the control points and enters the results on the spot from the tablet terminal and records them on the server. The recorded information can be retrieved from the server by the person responsible for the hygiene management, hygiene controller, at any time, from anywhere, using a tablet or PC terminal, for final verification and storage.

5 Electronic information for traceability

Figure 5.1 shows a sales plate with traceability information, Spain. In response to growing consumer interest, retailers are selling fish with plates containing not only the price but also information on where and how the fish was caught, under the initiative of the Catalan Consumer Agency.

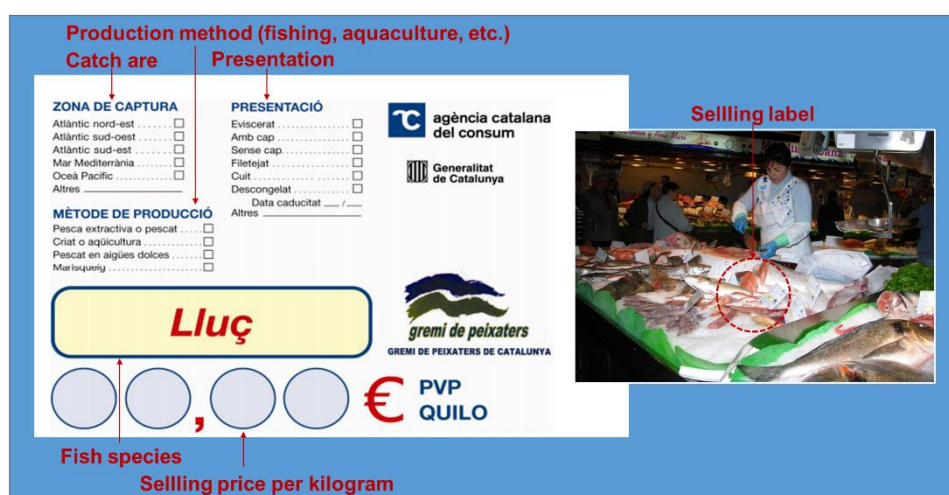


Figure 5.1 Sales plate with traceability information, Spain

The EU is described here as an example of how the necessary information is created, recorded and transmitted electronically in order to ensure traceability.

Lot-based traceability is the basic principle, and traceability information is transmitted on labels or vouchers by stating the lot ID, name and ID of the fishing vessel, species, catch date, weight or quantity, and catch area, etc. as shown in Figure 5.2. The contents of the label created in the auction hall can be referred to Figure 3.21 and 3.22. This also applies to aquaculture products. In the case of lot consolidation or lot split, the original lot ID corresponding to the new lot should be recorded.

Traceability information on the fishery products is recorded and stored electronically to the market's database through the sales process. The labels, landing statements, sales notices and other documents are completed and issued electronically. Since the auction hall is the starting point for traceability, the ICT and IoT - based sales process at the first sale of the fishing port contributes greatly to the establishment of precise and efficient traceability information towards the end consumers.

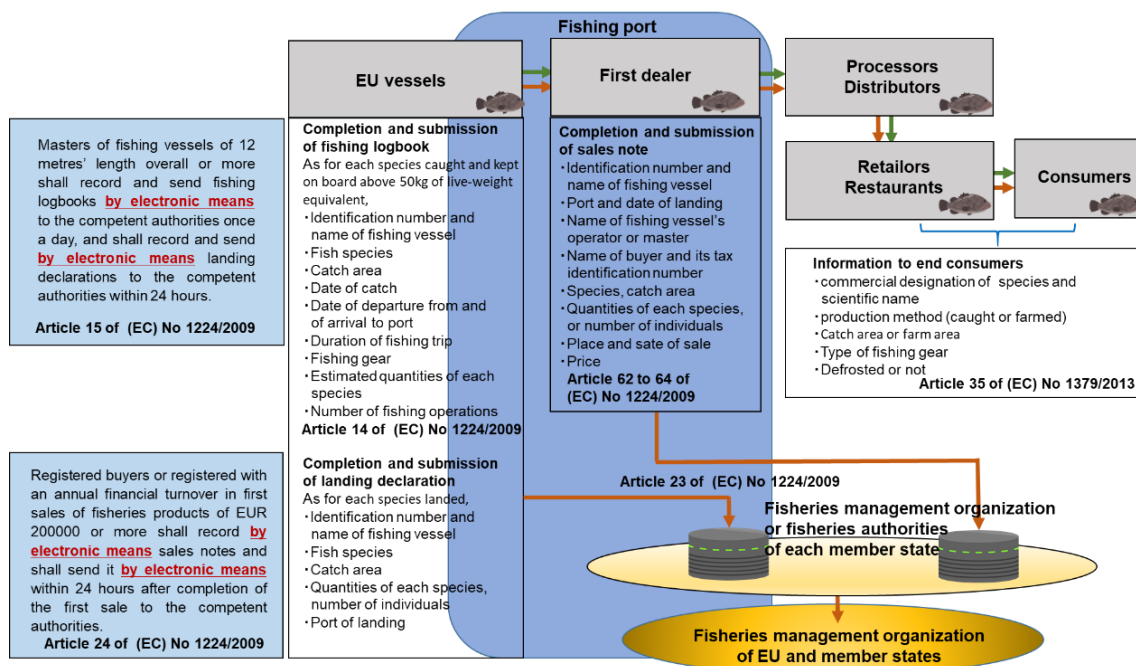


Figure 5.2 Recording, transmitting and displaying information on fish (fishery products)

6 Electronic report for fisheries resource management

The EU is described here as an example of how the fishing logbook information and sales information are reported electronically in order to ensure adequate fisheries management.

The logbook sheet is a form to be completed by the master of the fishing vessel during the fishing trip and by arrival at the port. The sheet consists of a catch part and a landing declaration, which is used when the catch is landed. The logbook holds information about: the vessel, gears applied, the fishing operations and estimated catches of landed fish. A section of the logbook sheet forms a landing declaration, with specification of each fishery product landed. The master of the vessel flying the flag of an EU Member State must, when arriving at the port, forward the logbook sheets to the fisheries authorities.

Table 6.1 shows the reporting information on fishing logbook, landing declaration and sales notes in EU. The master of a fishing vessel of 12 metres' length overall or more shall record logbook information and send it by electronic means to the fisheries authorities at least once a day, and also shall record landing declaration information and send it by electronic means within 24 hours after the completion of landing operation. The official statistics, which are based on the reporting from the buyers/receivers of fish, use the logbooks and the declarations of fishing area to acquire information on catch areas and third country fishing zones.

In 2009 and 2010, logbooks and their reports were still in paper form, but since around 2014 they have been electronic. The master of a fishing vessel logs in to a dedicated website or eLogbook and enter catch information such as when, where and how much they have caught. The quantity reported by the master and the quantity reported by the first sale or processing plant operator must be approximately the same, and the difference must be within a certain range. In France, the data is reported electronically by entering it on a dedicated website or by sending it by email (PDF).

Table 6.1 Reporting information on fishing logbook, landing declaration and sales notes

Master of the fishing vessel	Fishing vessel's overall length 12m or more	Record logbook information and send it by electronic means to the competent authorities at least once a day. Transmit the relevant fishing logbook data after the last fishing operation has been completed and before entering port (less-than 15m-long vessel operating within home EEZ or in a day exempted). Notify the competent authorities of logbook information at least four hours before arrival at port. Record landing declaration information and send it by electronic means to the competent authorities within 24 hours after the completion of landing operation.
	10m or more	Keep a fishing logbook. Submit logbook information as soon as possible and not later than 48 hours after landing. Complete and submit the landing declaration as soon as possible and not later than 48 hours after the completion of the landing.
	Less than 10m	Sampling-basis monitor exempts logbook requirements and landing declaration requirements.
Fishing port/market (First sale)	All fisheries products are first marketed or registered at an auction centre or to registered buyers or to producer organisations.	
	Annual turnover of EUR 200000 or more	Record sales notes information and send it by electronic means to the competent authorities within 24 hours after the completion of the first sale.
	Annual turnover of less than EUR 200000	Submit, if possible electronically, within 48 hours after the first sale, a sales note to the competent authorities. (As for fishing vessels of less than 10m or for quantities of not exceeding 50kg by species, sampling-basis system exempts sales notes requirements.)
Member states (Fisheries authorities)	Set up a computerised database for the purpose of validation of data recorded and a validation system no later than 31 December 2013. Ensure that all data recorded in accordance with this Regulation are accurate, complete and submitted within deadlines Perform cross-checking, analyses and verifications of the following data through automated computerised algorithms and mechanisms: (i) Vessel monitoring system data; (ii) Fishing activities data, in particular the fishing logbook, the landing declaration, the transhipment declaration and prior notification; (iii) Data from take-over declarations, transport documents and sales notes; (iv) Data from fishing licences and fishing authorisations; (v) Data from inspection reports; (vi) Data on engine power.	

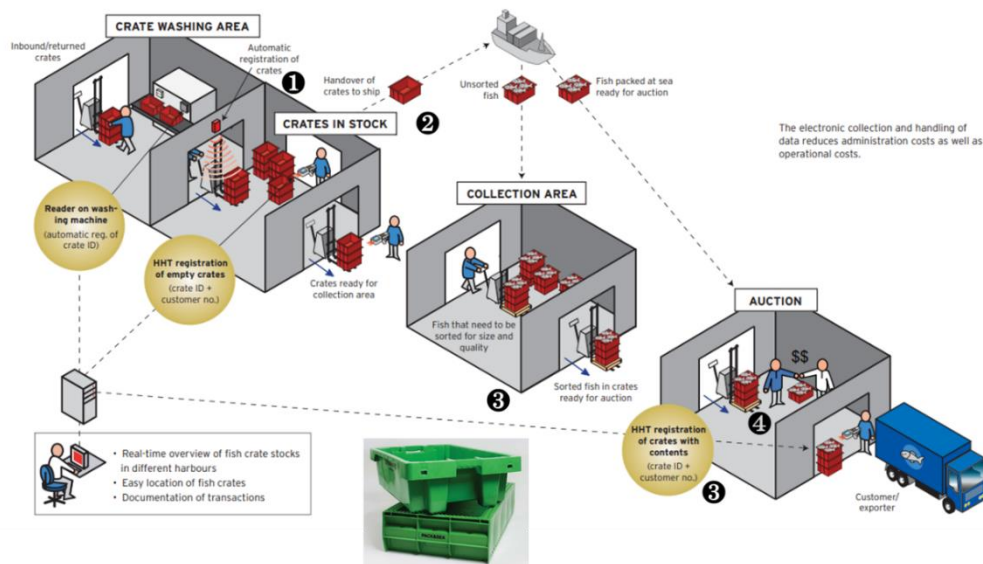
7 Electronic management of fish boxes

Fish boxes of a certain standard under the lending system have been used in fishing ports. In the past, it used to take time to find out where the lent fish boxes were, and to claim the fees to users. The automatic tracking system is now set up to ensure that the fish boxes are lent, collected, washed and stored in a reliable and efficient way, and that the washing process is mechanized and automated to save time and labour.

By identifying each fish box and electronically recording and storing information about the fish box (size and ID) and who is using it at the moment, fish boxes can be tracked in real time without any box lost. The system also saves time and labour by computerizing the calculation of fees and issue of bills. Furthermore, by linking the information on the fish box with the information on the fish in it, this tracking system makes it possible to ascertain when and where the fish was caught, landed, sold and transported. An automatic fish box washing machine makes it possible to carry out the washing work practically alone and in a short time. It is noted that standardized fish boxes must be used for the washing machine.

Figure 7.1 shows the diagram of lending out fish boxes and their automatic tracking system serviced by Pack and Sea A/S, Denmark. Pack and Sea A/S uses standardised fish boxes, which are managed by the fish box tracking system using RFID tags with barcodes attached to the boxes. When a fishing vessel rents fish boxes from Pack and Sea A/S, while boxes are passing through the gate from the storage, the RFID tags attached to the fish box is scanned and the name of the fishing boat (or code) is entered with a gate reader or a hand-held reader. The Pack and Sea's tracking system records the information about the lent fish boxes. When the fish boxes with fish in are delivered to the auction hall and sold, the RFIDs of the fish boxes are scanned again and the buyer's name (or code) is entered, and the renter of the fish boxes is changed from the fishing vessel to the buyer.

At each port there are facilities for collecting, washing and storing fish boxes, the operation of which is entrusted to the auction hall organization or fishery cooperative in general, so that the fish boxes can be used at any fishing port in Denmark and returned at the nearest port after use. For use abroad, there are fish box collection points in Sweden, Germany, the Netherlands, Belgium, the UK and France, to which the fish boxes can be returned.



Source: <https://www.packandsea.dk/eng/>

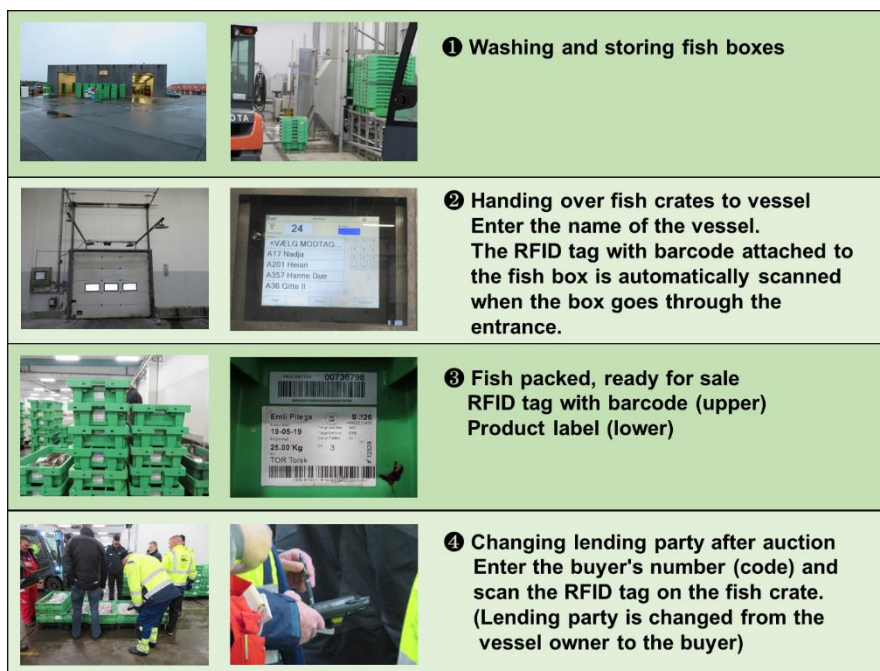


Figure 7.1 lending fish boxes and their automatic tracking system, Denmark

8 Electronic information on meteorology and oceanography

Fishing ports, as bases for fishing operations, must ensure the safety and efficiency of operations, as well as in the ports and on waterways, and be also resilient to natural disaster.

Meteorological and oceanographic information are essential for these purposes in day-to-day fishing activities as well as in planning the development and improvement of fishing ports, designing of facilities, management and operation.

8.1 Classification of information

- Meteorological information includes live or forecast ones as follows:
 - Wave direction, height and length;
 - Wind direction and speed;
 - Weather map;
 - Tide;
 - Atmospheric pressure distribution map;
 - Precipitation; and
 - Warning and emergency information (Typhoon, Storm, Tsunami, Earthquake, Surge, Swell, etc.).
- Oceanographic live or forecast information includes live or forecast ones as follows:
 - Satellite image of sea surface temperature;
 - Sea temperature;
 - Satellite image of sea surface colour;
 - Salinity concentration;
 - Current direction and speed;
 - Sea surface height anomalies; and
 - Fishing operation map.
- Other information is also available as follows:
 - Live images (inside and outside the harbour, fishing grounds and routes).

8.2 Observation, analysis and dissemination

The organizations concerned - for example, meteorological observatories, the Coast Guard, the port administration such as the Port Authority and local government, information service companies and research institutes - observe and analyse the data and provide it to users. Users may selectively use the content of the meteorological and oceanographic information according to his purpose. A one-stop service that allows users to access all the information they need at a fishing port will improve their convenience and enhance the role and function of fishing ports.

8.2.1 Types of information

Chronologically, the meteorological and oceanographic information can be divided into three types:

- Live information, which distributes observed data in real time;
- Forecast information, which calculates values several hours to several days ahead by simulation based on measured data; and
- Statistical information, which is statistical processing of past data.

The use of forecast information is expanding as the accuracy and calculation speed of simulation models improve.

8.2.2 Observation system

Observation is based on a telemetering system in which data are automatically acquired by remotely located measuring sensors, transmitted to a monitoring centre using radio or dedicated telephone lines, and the data obtained are centrally managed.

The sensors are mounted on observation buoys, observation towers or observation vessels, or a measuring instrument equipped with a sensor is placed on the seabed. Doppler LiDAR (Light Detection and Ranging) has been developed to remotely measure wind speed and direction at sea, enabling measurements to be made at remote points above and ahead on the sea where conventional sensors

cannot. There are two types of LiDAR: Scanning LiDAR, which is installed on land, and Floating LiDAR, which is installed at sea.

Examples of the major observing system are as follows:

1 Radar coastal wave meter;

The radar coastal wave meter measures the height, period and direction of significant waves by emitting radio waves (microwaves) from the coast towards the sea surface and measuring the reflected waves modulated by the Doppler effect in response to the movement of the sea surface caused by waves.

2 Ultrasonic coastal wave meter;

Figure 8.1 shows the diagram of ultrasonic coastal wave observing system. The ultrasonic coastal wave meter measures sea level fluctuations by placing ultrasonic transmitters and receivers on the seabed and measuring the time it takes for ultrasonic waves emitted from the water to be reflected back to the sea surface. By continuously measuring these fluctuations in water level, we can determine the fluctuations in sea level and statistically process them to observe the waves on the sea surface. The signals from the sensors are digitised at an observation station on a nearby beach, combined with a check signal on the transmission, and then sent to the monitoring station.

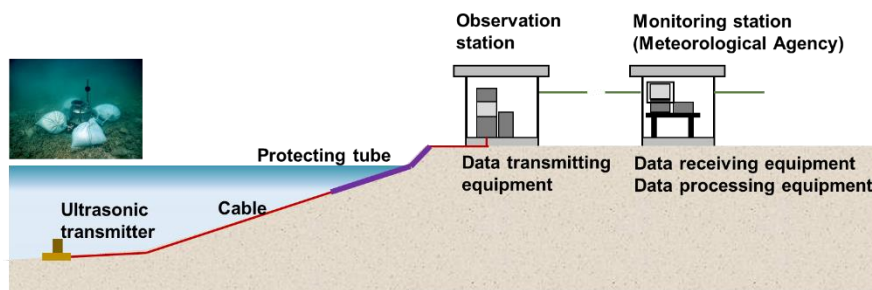
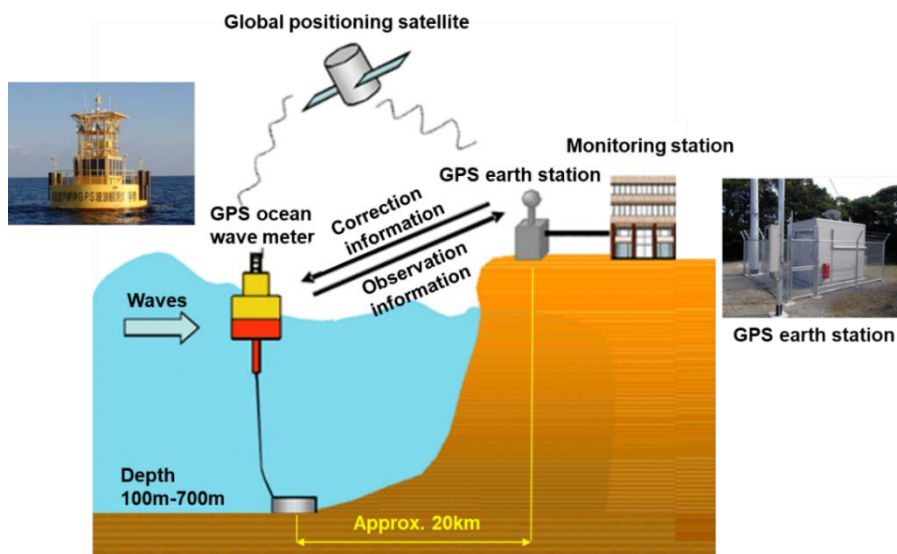


Figure 8.1 Ultrasonic coastal wave observing system

3 Multi-functional oceanographic measuring instrument;

The multi-functional oceanographic measuring simultaneously instrument can measure wave height, wave direction, current direction, current velocity and water temperature in a single unit. It is possible to construct a communication system using radio equipment.



Source: <https://www.mlit.go.jp/report/press/>

Figure 8.2 GPS ocean wave observing system

4 GPS ocean wave meter; and

Figure 8.2 shows the diagram of GPS ocean wave observing system, Japan. The GPS ocean wave meter uses the Real Time Kinematic GPS (RTK-GPS) system, which is a satellite-based positioning system, to measure the vertical movement of buoys floating offshore such as waves and tides offshore with an accuracy of a few centimetres, which is necessary for port and harbour maintenance. The system is also used to monitor long-period waves such as tsunamis, and is used to prevent tsunamis at fishing ports and their hinterland areas.

5 Floating Lidar buoy.

The Floating Lidar buoy is a compact measuring instrument for waves, current profile as well as wind profile as shown in Figure 8.3.



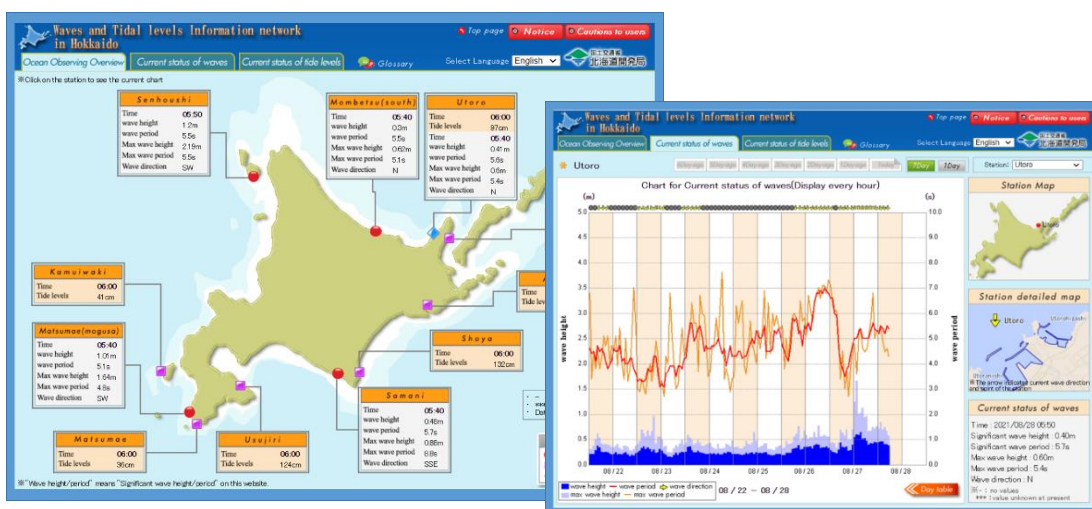
Source: <https://www.fugro.com> (left, middle), <https://oceantechusa.com/> (right)

Photo 8.3 Floating Lidar buoy for measuring wind profile, etc.

8.2.3 Methods of providing information

Information can be provided to users in the following ways:

- Through the website of the organization providing the information. Depending on the content of the information, they may be able to access it by registering in advance and entering their ID and password; or
- By email to addresses of pre-registered users.



Source: <https://www.hkd.mlit.go.jp/>

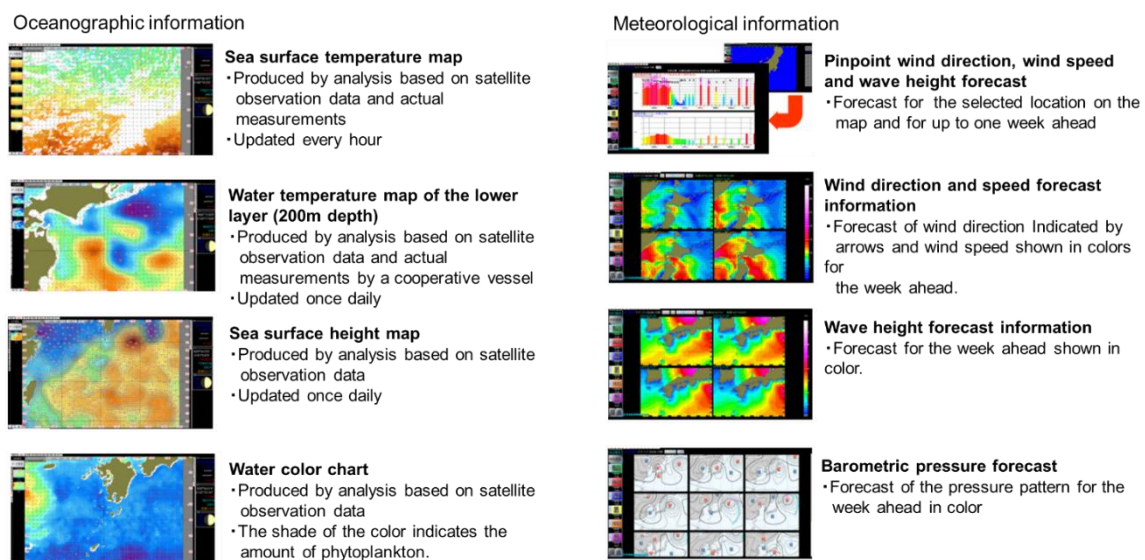
Figure 8.4 Wave and tidal levels information network, Japan

The information provided must have the required accuracy and must be correctly and easily understandable by the user. So the information is generally presented not only in numerical form, but also in the visual form of graphics, such as diagrams or moving images (animations) that change with time.

In offshore areas, oceanographic information related to the formation of fishing grounds is analysed and simulated from data observed by various satellites or measured by vessels equipped with sensors, and provided through satellite communication.

Figure 8.4 shows the wave and tidal level information at fishing ports in a region, as provided by the website of the national government, Japan.

Figure 8.5 shows the meteorological and oceanographic information for fisheries, the Japan Fisheries Information Service Centre (JAFIC), Japan. JAFIC provides information on water temperature, currents and weather, which is useful for fisheries, via the JAFIC's website. Oceanographic information is produced by JAFIC's own analysis of data observed by various satellites and actual measurements from the fishing vessels that help JAFIC with its observations. Meteorological information is originated in what is produced by the Japan Meteorological Agency (JMA) and is distributed by the Japan Meteorological Services Support Center (JMSSC).



Source: <https://www.jafic.or.jp/service/ebisukun/>

Figure 8.5 Meteorological and oceanographic information services for fisheries, Japan

9 Electronic management of vessel traffic and fishing

9.1 General

The Automatic Identification System (AIS) and the Vessel Monitoring System (VMS) are both useful systems that meet the basic needs of safe navigation and fishing operation and sustainable fisheries management.

As shown in Figure 9.1, AIS is a system that automatically transmits and receives information on the ship's identification code, type, position, course, speed, navigational status and other safety-related information via Very High Frequency (VHF) radio broadcasting system, which enables AIS equipped vessels and shore-based stations to send and receive identifying information. Since AIS was developed to show where any vessel was, to avoid collisions, AIS functions as improving safety for sailors and vessels.

Figure 9.2 shows an image of how the VMS works. Different VMSs use different communication technologies depending on the functionality requirements imposed by a national or regional VMS initiative. VMS functions as a passport for fishermen to prove their catch is compliant with conservation measures and is better suited for fisheries management for the following reasons:

- VMS can support larger data transfers, thereby opening the way for other added services such as e-logbooks as described above; and
- VMS preserves a flag state's sovereignty over its waters and resources because it is a secure system guaranteeing data delivery.

As governments and regional fisheries management organizations (RFMOs) work to monitor the oceans and the blue economy, and to achieve sustainable fish stocks, VMS can deliver the enhanced monitoring and surveillance demanded worldwide, while providing fishermen with the certainty they meet fisheries regulations.

Fishing vessels equipped with AIS or VMS are currently limited to certain vessel sizes (total length or total tonnage) and certain forms of fishing (offshore, deep-sea fisheries or fishing over several days).

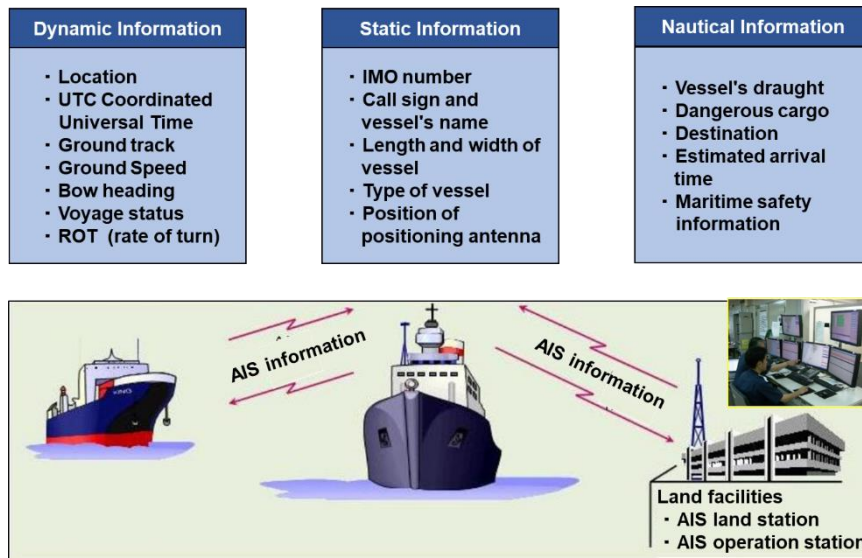


Figure 9.1 AIS-based navigation aid system

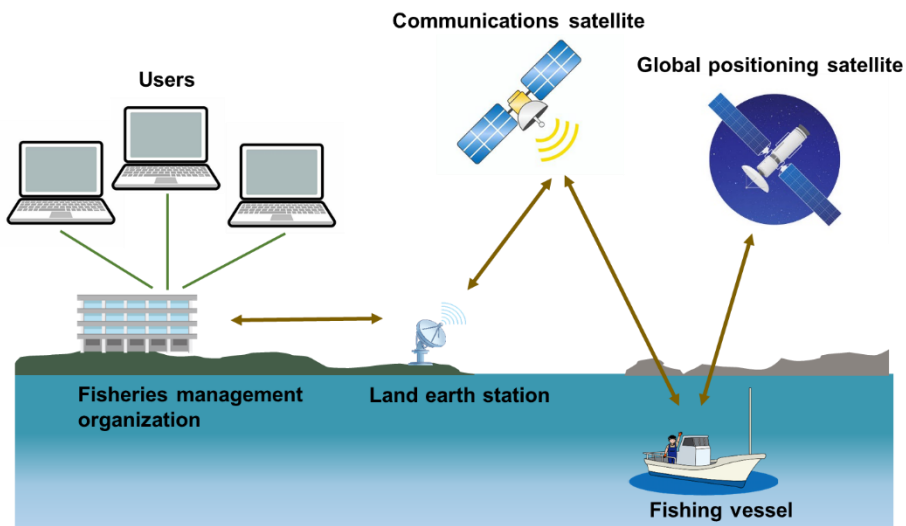


Figure 9.2 Image of how a vessel monitoring system (VMS) works

9.2 Vessel traffic service (VTS)

Since the 2000s, AIS has been set as the standard for vessels subject to the International Convention for the Safety of Life at Sea (SOLAS). Initially, AIS signals were received through coastal networks of land stations. Designed to be a collision avoidance system, not a global vessel tracking system, AIS has

saved lives at sea by improving the safety of navigation. AIS is not mandatory on smaller vessels but many are using it simply because of its safety benefits.

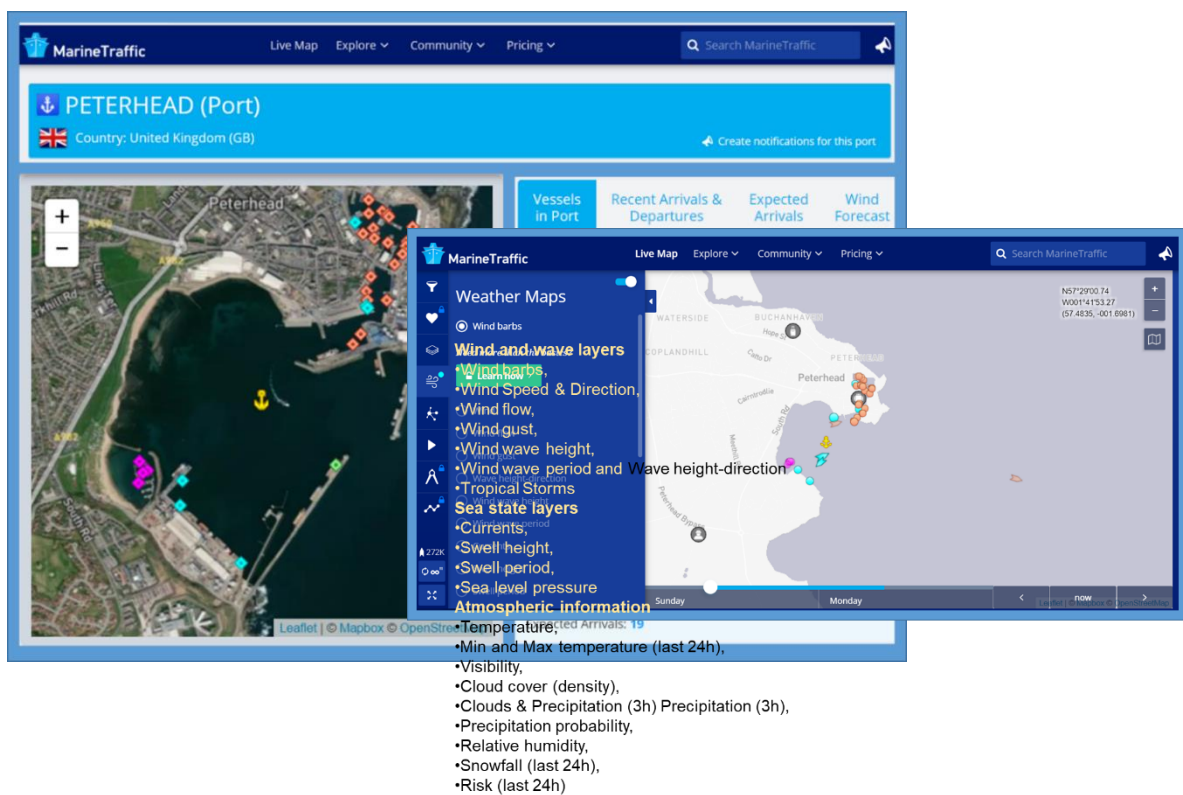
Vessel Traffic Service (VTS) using AIS is now established as a service that provides information to vessels on the location of other traffic and weather warnings, and manages a wide range of traffic in ports and on waterways.

Figure 9.3 shows the MarineTraffic website as an example of VTS and its various services. MarineTraffic, the world's leading provider of ship tracking and maritime intelligence, is an open, community-based project, which provides real-time information on the movements of vessels and the current location of vessels in ports or waterways and makes actionable information to provide the shipping, trade and logistics industries with actionable insights. The basic MarineTraffic services can be used without cost; more advanced functions such as weather information, Weather Maps, are available subject to payment.

Data is gathered from in excess of 18,000 AIS equipped volunteer contributors in over 140 countries around the world. Information provided by their network of coastal AIS-receiving stations, supplemented by satellite receivers, such as unique identification, position, course, and speed is then transferred to the main Marine Traffic servers for display via the website in real time. The site uses Google Maps as its base mapping.

A database of information on the vessels includes for example details of the location where they were built plus dimensions of the vessels, gross tonnage, photographs of the vessels and IMO number. Vessel positions can be combined with weather information as follows:

- Access Weather Maps and combine them with vessels positions on your MarineTraffic Live Map;
- Switch between Wind and Wave, Sea State and Atmospheric Layers to visualize current and forecast weather information; and
- Keep up-to-date with the weather conditions to help ensure the safety of vessel and crew, as well as being able to optimize sailing routes.



Source: <https://www.marinetraffic.com>

Figure 9.3 MarineTraffic website and services

9.2 Vessel monitoring system (VMS)

VMS is a system that is used in fishing to allow environmental and fisheries regulatory organizations to track and monitor the activities of fishing vessels. They are a key part of Monitoring Control and Surveillance (MCS)* programs at regional, national and international levels. VMS is used to monitor vessels in the territorial waters of a country or a subdivision of a country, or in the Exclusive Economic Zones (EEZ) to improve the management and sustainability of the marine environment, through ensuring proper fishing practices and the prevention of illegal fishing, and thus protect and enhance the livelihoods of fishermen.

*MCS is defined by the Food and Agriculture Organization (FAO) as a broadening of traditional enforcing national rules over fishing, to the support of the broader problem of fisheries management.

Within regional and national VMS initiatives there are also sub-divisions which apply different functionality to different vessel categories. Categories may be size or type of vessel or fishing. For example:

- Local/regional fish such as scallops in the Northeast U.S., anchovies in Peruvian waters, or rock shrimp in the Gulf of Mexico; and
- The Western and Central Pacific Fisheries Commission (WCPFC) is a treaty-based organization established to conserve and manage tuna and other highly migratory fish stocks across the western and central areas of the Pacific Ocean.

VMS, employed in almost every fishing vessel in the world today, is an easy and reliable way of tracking fishing vessels for numerous purposes and has become an indispensable part of the fishing industry and that further development in science and technology would make it even more crucial as well as convenient.

VMS is intended principally for fisheries management, while the country using it may use the data for the following purposes:

1 Fisheries management;

Among all the most basic purposes is to monitor the movement of VMS-equipped vessels with respect to restricted fishing areas. A given vessel may have approval to fish in a restricted area, to transit through it without fishing, or it may not be allowed in the area.

2 Catch reporting electronically; and

A master of the fishing vessel is required to catch reporting electronically. The Electronic Reporting System (ERS) is a complex system for recording, reporting, processing, storing and transmitting fisheries data (catch, landing, sales and transshipment). The key element of ERS is the electronic logbook, which is used to record and transmit in a secure way details of fishing operations.

ERS enables better control of fishing activities, more accurate stock assessment and sustainable management of marine resources. ERS reports provide governments and fishing managers with data for fisheries statistics that are both dynamic and reliable. A database captures and stores the catch information and makes it available to view on board, saving work with respect to logging catch information, helping plan future fishing trips and reporting mandatory information to fishing authorities electronically.

3 Fisheries research and analysis.

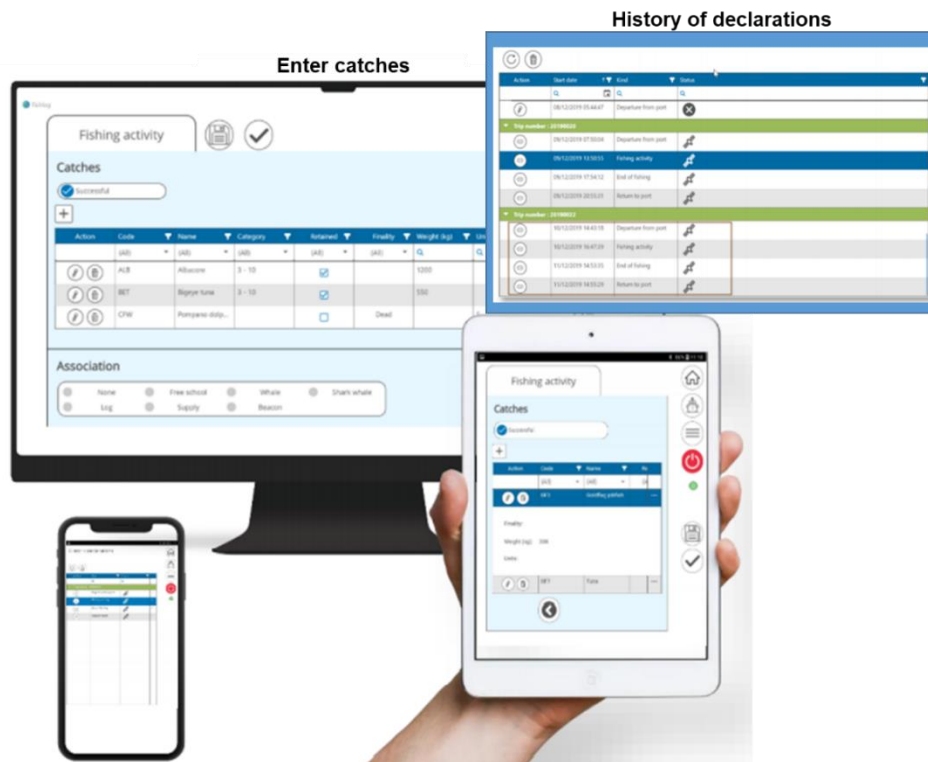
Treated as a research database, the cumulative position reports gives an analysis of fishing vessel tracks in search of fish. Coupled with species-specific fishing licenses and catch reports, fisheries authorities or fisheries management body can estimate the amount of a given fish in an area, the amount taken by fishing vessels, and project overfishing before it happens.

The Department of Fisheries, Western Australia is carrying out real-time monitoring of commercial fishing fleets to ensure fishers are working in their designated fishing areas and/or within their catch entitlement allocations, by the use of VMS in most of Western Australia's fisheries. In the EU and US there is a distinct trend to making catch reporting part of an overall MCS program. One system that does to this is Fulcrum Maritime Systems Limited's Vessel Tracking Service which uses the latest data rich satellite application technology to enable electronic catch reports to be sent from the vessel to the VMS

directly and automatically sends the report and vessel position data to the RFMOs or other fisheries management body, such as the North-East Atlantic Fisheries Commission (NEAFC).

The Collection Localisation Satellites (CLS) is one of global leaders for VMSs. As requirements increased, VMS has evolved to work with other systems, resulting in his opened up a number of possibilities, including the transmission of weather forecasts and storm warnings, and the introduction of electronic catch reporting. In addition to monitoring services, CLS now supplies fishermen with electronic reporting software and applications that are transferred to ship owners or fishing authorities and research institutes by the VMS beacon.

Figure 9.4 shows the FISHLOG, a catch reporting software that works across all devices: PCs, tablets, and smartphones. Any national or regional fisheries regulations can be integrated. It can also send reports via the Triton VMS terminal over the Iridium satellite network, or store reports for sending later.



Source: <https://www.cls.fr/en/>, <https://fisheries.groupcls.com/>

Figure 9.4 FISHLOG, electronic catch reporting software, CLS

10 Electronic financial management

The computer is one of the most important tools for the financial management of the fishing port. Like in any other business, the fishing port management must get detailed timely financial statements and be able to compare these with budgeted forecasts.

Some of the most important arts of the financial computer system are 1 the general ledger, 2 the payroll and 3 the invoicing or accounts receivable. The needs of a fishing port are in most respects similar to other businesses in this respect.

It is essential that the port charges cover the daily operational costs and, depending on the port structure of the country, they must cover at least part of the capital costs* and maintenance costs. To make ends meet, all possible income-generating services must be charged for. The charges that can be billed include the followings:

- Landing charge, based on the value of the landed fish, and on the quantity of the landed fish;
- Berthing charge, bases on the DWT of the ship and home vessel or foreign vessel, rate based on period of use;

- Service charges for water, ice, electricity, fuel and waste disposal based on quantity;
- Sorting, grading and weighing charges;
- Auction fees, usually a percentage of the value of the fish at the auction;
- Rents for lots or buildings provided;
- Rents for fish crates;
- Slipway and lift charges; and
- Miscellaneous sales of goods.

These charges may be invoiced by the port administration, the fish market organization or other service individual concerns running the various services, such as slipways, ice manufacturing facilities, auction halls, etc.

*Capital cost is the fixed, one-time cost of constructing breakwaters, wharves, water facilities, etc., land and buildings, and purchasing equipment, etc., used in the development of a fishing port or provision of services. In other words, it is the total cost of a fishing port project. In terms of financial management, the total cost excludes the cost of the part developed as public works or using government funds. However, this is not the case in cost-benefit analysis.

11 Considerations in the ICT, IoT utilization for small fishing ports

Small fishing ports (defined here in terms of the amount of fish landed and the number of vessels using them) face financial difficulties in maintaining, renewing and expanding them; the same financial difficulties apply to the utilization of ICT and IoT. As discussed in Section 1.2 Objectives and effects, the fundamental requirements for the utilization of ICT, IoT for fishing ports are that either:

- Large amount of fish are sold, including directly landed or brought in by land and sea, or there is a market there; or
- Fisheries are in operation to such an extent that it has an impact on resource management.

In small fishing ports, the need for and effects of ICT, IoT utilization is generally considered low, as landings are mainly locally produced for local consumption, the species of fish caught are limited by season and the catch is not high enough to affect the resource.

In contrast, 1. fishermen themselves can improve their fishing management by utilizing ICT, IoT, and 2. the role and functions of individual small fishing ports can be enhanced by utilizing ICT, IoT not for individual small fishing ports, but for fishing ports as a whole in the region.

1. Utilization of ICT, IoT by the fishermen themselves

Direct sales to local residents or wholesale to specific restaurants and fishmongers, but fishermen can set up their own websites to expand the sales channels for the fish they catch. They offer their catches in their own restaurants and pensions, as in the case of Pescaturismo.

2. Utilization of ICT, IoT for fishing ports as a whole in the region

When the port administrations or fishery cooperatives of each fishing port in the region work together and taking in a holistic manner, the utilization of ICT, IoT can be expected to enhance the whole role and functions of fishing ports in the region including small fishing ports.

• Virtual market

Even though it is difficult to construct a market in the real world, it is possible in cyberspace to create a virtual market in cooperation among the port administrations or fishery cooperatives in the region. Figure 10.1 shows the image of a virtual market among small fishing ports in the region. Sales and logistics are separate in the virtual market. In addition to auction sales, negotiated sales and sales to order are allowed to consumers, fishmongers and restaurants. After the sale, fish are dispatched by the fishermen to the buyers.

• Market integration

In order to enhance competitiveness under resource management, there has been a trend in regional fishing ports towards market integration into the base fishing port. As shown in Figure 10.2, market

integration can take either landing and distribution are centralized at the base fishing port, or landing takes place at each fishing port and All the landings are centrally auctioned off at the auction hall in the base fishing port. The latter is a separation of sales and logistics; after the sale, fish are dispatched directly from each fishing port.

The utilization of ICT, IoT enables the creation of a virtual market and facilitates market integration. In particular, ICT, IoT are essential for market integration that involves the separation of sales and logistics; through ICT, IoT-utilized virtual markets and market integration, the sales channels from small fishing ports will be expanded and their role and functions will be maintained and increased.

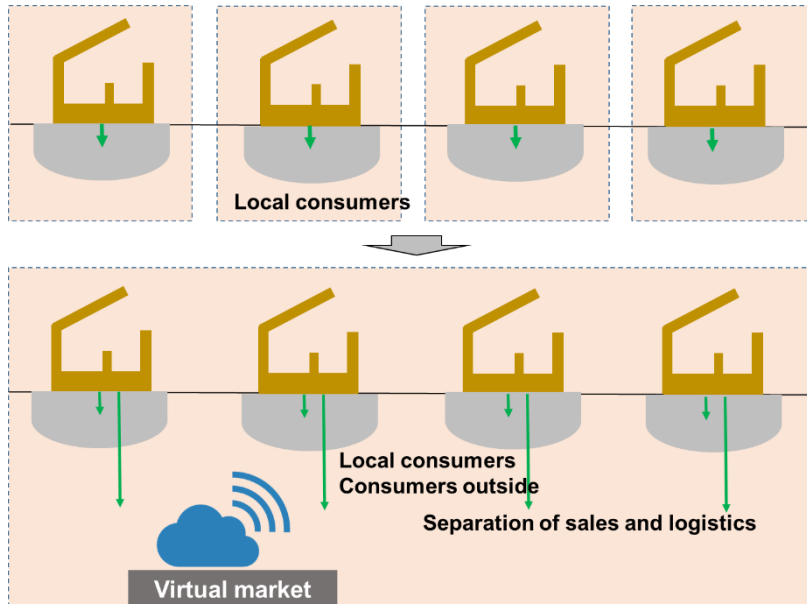


Figure 10.1 Virtual market among small fishing ports in the region

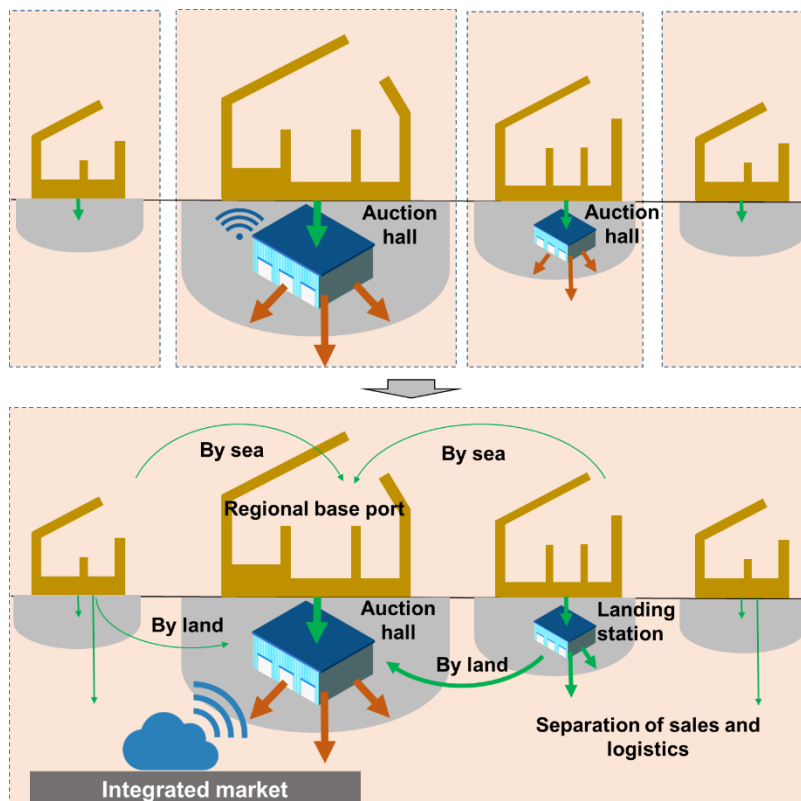


Figure 10.2 Integrated market involving small fishing ports in the region

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COUNCIL REGULATION (EC) No 1224/2009

Article 14 Completion and submission of the fishing logbook
Article 15 Electronic completion and transmission of fishing logbook data
Article 16 Fishing vessels not subject to fishing logbook requirements
Article 17 Prior notification
Article 23 Completion and submission of the landing declaration
Article 24 Electronic completion and transmission of landing declaration data
Article 25 Vessels not subject to landing declaration requirements
Article 59 First sale of fisheries products
Article 60 Weighing of fishery products
Article 62 Completion and submission of sales notes
Article 63 Electronic completion and transmission of sales notes data
Article 64 Content of the sales notes
Article 65 Exemptions from sales notes requirements
Article 109 General principles for the analysis of data

COUNCIL REGULATION (EC) No 104/2000

Article 4

COUNCIL REGULATION (EC) No 2065/2001

Article 8, Article 9

COUNCIL REGULATION (EC) No 1005/2008

Article 12 Catch certificates
Article 14 Indirect importation of fishery products

COUNCIL REGULATION (EC) No 1224/2009

Article 56 Principles for the control of marketing
Article 58 Traceability

COUNCIL REGULATION (EC) No 1379/2013

Article 35 Mandatory information

MAGNUSON–STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

Contents of fishery management plans 16 U.S.C. 1853

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