Transparency within the seafood sector

Semantic interoperability between certifications and regulations connected to fishery products

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1. Introduction

The introduction section includes background to the report, the purpose, research questions and potential limitations needed to be taken into consideration.

1.1. Background

In modern society, there is a growing demand for reporting of information to various governments and authorities. Globalization and increased consumer awareness of food safety have been major contributions to the need for traceability in the food sector. Especially important has the seafood sector been targeted by public media and consumers due to its complex supply chains and its important role in feeding the world's populations.

Approximately 20% of the global population intake of animal protein is from fish and 13% of the population is reliant on the seafood sector (Nurdiani et al., 2020; GSSI, 2019). This accentuates the importance of the seafood sector on an environmental, economic and social scale. UN's Sustainable Development Goals (SDG:s) can identify many places where the seafood industry can make progress (Global Seafood Alliance, n.d.). As noted by the research into the seafood sector by Lewis & Boyle (2017), where money is to be made, fraud will be prevalent. Therefore, implementing traceability systems and having Non Governmental Organizations (NGO) involved in the seafood supply chains follow standards and certificates would be key to enforcing proper food safety regulations, fight fraud and fulfill sustainable expectations of consumers and authorities (Leal et al., 2015).

1.2. Purpose

One of the aims is to monitor and trace certain events and items. This report will cover different standards and certification bodies within the seafood and fishery industry. Companies involved in the seafood industry are facing increasingly stricter commercial and regulatory demands for traceability of seafood products due to a number of reasons: Increased attention from the public and the media with many stories of illegal harvesting of fish, human rights abuse and seafood fraud (Lewis & Boyle, 2017). These issues have had direct negative consequences for involved seafood companies and as a result led them to look for third party traceability tools as a commitment towards sustainability. Furthermore, the report also describes the relationship of the standards in a supply chain setting.

1.3. Research questions

The first research question is to analyze the semantic relationship between certification standards and regulations related to traceability within the seafood and fishery products sector. While the second question is to analyze the certification based on a supply chain perspective.

1.4. Delimitations

The scope of this literature report is limited to scientifically published articles and books as well as certification and standard websites published in English between 1995 and 2022. The articles that were included in this review focused on traceability in the seafood sector or subjects relevant to traceability

in the sector, such as semantic interoperability. Furthermore, since the seafood sector is broad and varying depending on the region, the report is limited to European regulations and laws.

2. Theory

This section focuses on the theories that are covered in the report.

2.1. The Global Dialogue on Seafood Traceability

The Global Dialogue on Seafood Traceability (GDST) is an international initiative with the purpose to improve traceability of seafood products for the many stakeholders involved in the seafood supply chain. The GDST was founded in 2017 by two dozen of companies to outline industry-led standards focusing on interoperability and verifiability for all the seafood tracing systems in use (GDST, 2022).

According to GDST (2022) it is now adopted by 60 companies and across the entire seafood supply chain. However, the GDST does not create its own standards or certifications. It is simply a business to business platform creating guidelines and promoting the use of current existing traceability certifications, standards and developing solutions based on these standards. Some of the traceability standards implemented by GDST are: the Aquaculture Stewardship Council (ASC) Traceability Standard and the Marine Stewardship Council (MSC) Chain of custody standard.

2.2. The Marine Stewardship Council Fisheries Standard

The Marine Stewardship Council Fisheries Standard is an international standard for sustainable fishing based on the United Nations Food and Agriculture Organization (FAO) guidelines. It is also used as an assessment of the management of fisheries and its sustainability. It is provided by the MSC, an international non-profit organization. The standard is based on three principles: the fish stock is being harvested at a level that allows for its long-term viability; the fishery has minimal impact on the marine ecosystem; and the fishery is managed through effective governance (Marine Stewardship Council, n.d.).

2.3. The Global Sustainable Seafood Initiative

The Global Sustainable Seafood Initiative (GSSI) purpose is to provide a sustainable future by protecting the ocean and developing green production of seafood. To reach the goal GSSI collaborates with businesses, NGOs, governments, and organizations. These actors represent the seafood value chain. Furthermore, it is mentioned that GSSI has close connections and works with the FAO to gather stakeholders to ensure that a common goal is reached. The main service of GSSI is to provide benchmarks for certification. However, the organization does not have any own certifications (GSSI, n.d.).

2.4. Electronic Product Code Information Service

Electronic Product Code Information Service (EPCIS) is a standard for sharing information about the movement and status of physical objects in supply chain and logistics systems. It enables different organizations and systems to exchange data about the movement and status of goods as they are produced, shipped, received, and consumed. The purpose of EPCIS is to provide a common language and framework for tracking and sharing data about the movement and status of goods in order to

improve supply chain visibility and efficiency. EPCIS data can be used for various purposes, including tracking the movement of goods through the supply chain, identifying bottlenecks and inefficiencies, improving inventory management, and enabling greater collaboration between different organizations and systems (EPCIS, n.d.).

2.5. The UN Sustainable Development Goals (SDGs)

The United Nations (UN) 17 Sustainable Development Goals (SDGs) is a universal call to promote sustainable development throughout the world as part of Agenda 2030 (United Nations, 2015). The Global Seafood Alliance (GSA), is another international NGO advancing responsible seafood practices on environmental and social issues (Global Seafood Alliance, n.d.). Moreover, GSA has identified seven goals relevant to the seafood sector, as shown in table 1.

Table 1.
Sustainable development goals connected to GSA

SDGs	**Description and relevance to the Seafood sector**
SDG #2 - Zero Hunger	Seafood is a nutrient dense staple protein around the world, increasing the production of seafood in an ethical manner would help reduce global hunger.
SDG #5 - Gender equality	The seafood industry provides job opportunities and a stable income. The labor force in the industry is estimated to consist of approximately 50% women. Most notably in processing. Women are rarely seen in higher positions which implies there is work to be done for SDG #5.
SDG# 8 - Decent Work and Economic Growth	The seafood industry is in many regions a key employer to poverty ridden people. Hence, the industry is a great contributor to economic growth, especially in rural and coastal communities with limited job opportunities. If implemented ethically it can help people get out of poverty.
SDG #10 - Reduced Inequalities	SDG 10 has the aim of striving towards reduced inequalities in countries and is closely related to SDG 5. The seafood industry generates job opportunities for poverty-stricken communities as well as providing nutritious food which help reduce inequalities.
SDG #12 - Responsible Production and Consumption	UN's SDG 12 aims to ensure sustainable consumption and production patterns. How this

	is related to the seafood industry is that applying sustainable fishing and aquaculture practices would help minimize environmental impacts and help preserve the maritime ecosystem and the services it provides. Furthermore, the seafood industry can play a role in promoting sustainable consumption by producing and marketing sustainably-sourced seafood products and providing information to consumers about the environmental impacts of their food choices.
SDG #13 - Climate Action	SDG 13 aims to “take urgent action to combat climate change and its impacts”. How this relates to the seafood industry can be traced to the production of seafood being a source of GHG emissions, especially from the use of fossil fuels in fishing vessels and logistics. This can be reduced by the use of more efficient and sustainable fishing and transportation methods. The industry could also help adapt to the impacts of climate change by developing more sustainable production systems.
SDG #14 Life Below Water	SDG 14 is about conserving and using the oceans, seas, and marine resources for sustainable development. It is relevant to the seafood industry because it aims to ensure the sustainable use of marine resources, including fish, which are a major source of food and livelihoods for people around the world.

2.6. Semantic interoperability

The concept of semantic interoperability refers to the common understanding between components in systems. The base for semantic interoperability is agreements, e.g., data sent can be error codes, message passing protocols and procedure names. One difficulty in semantic interoperability is the system needs to be updated with the similar information. For instance, if customer data is needed from one system to another, it needs to be defined in both systems (Heiler, 1995). The interoperability can enhance an object, such as a container, by collection of data used in connection to the unit. For example, data such as the amount of product being transported and unit loads (Ringsberg, 2022).

3. Methods

The report was structured as a literature study. The primary data collection method is theoretical, including documents from certification bodies and published scientific literature and reports. A systematic search of several online databases was conducted. No specific time frame for the searches were concluded. All studies published in English were included. The studies' titles and abstracts were independently screened for relevance. The full articles were then acquired for the studies meeting the inclusion criteria. Furthermore, the analysis was made to provide a base to the research questions.

First a summary was made to describe GSSI, GDST and MSC and what the mentioned organizations purpose is. The discussion section contains the research questions as subtitles to answer them. This was done by complying information provided throughout the report. Also, by using the summary made in the results section with other sources. In addition to this, the result was reflected upon and the authors own conclusions and thoughts were provided linked to the content. Finally the conclusions summarized the report and connected the results with the discussion to answer the research questions.

4. Results

This chapter contains the results of the report. It is based on sources related to the standards and certification bodies.

4.1. The Global Sustainable Seafood Initiative summary

The purpose of GSSI is to enable seafood as a driver to preserve oceans. Working towards sustainability to future-proof seafood for coming generations. The organization is doing this by collaborating with actors within the seafood industry.

According to “More sustainable seafood for everyone” by GSSI (2019) 13% of the global population is reliant on the seafood sector. Therefore, seafood and fishery products need to be developed and evolved in a sustainable manner. This also includes the work connected to the sector. In terms of workers there are approximately 59,6 million employees directly associated with aquaculture and fisheries. Furthermore, when counting the indirectly connected employees it numbers approximately 239 million within the seafood sector. To reach the targets GSSI uses the UNs sustainable development goals as landmarks.

It is also mentioned that the expected increase of seafood production is over 500% from the 1960 to the 2030 (GSSI, 2019). This is also a factor to the need for sustainable development and production related to the area. To achieve certification, a benchmarking tool is used. There are seven steps included:

1. Application
2. Desktop review
3. Office visit
4. Benchmark committee meeting
5. Public consultation
6. Recognition decision by steering board
7. Monitoring of continued alignment

GSSI’s main service is benchmarking, which is graded by completing a test provided by the organization. When the benchmark is completed, the user receives a formal recognition of seafood certification if the benchmark was fulfilled. GSSI argues that the tool is needed to acquire a sustainable future, by certifying sectors related to fisheries and aquaculture. As the mentioned areas are growing and need to be controlled in the right manner to ensure that the fish stocks are not depleted. Moreover, GSSI claims that the tool improves and addresses the latest problem within seafood sustainability.

The tool is constructed by a framework, a process and lastly the result. There are four sections named in alphabetical order used to assess the user.

A. Governance of seafood certification schemes
B. Operational management of seafood certification schemes
C. Aquaculture certification standards
D. Fisheries certification standards

The A and B schemes are used in every assessment, but C and D are used if it is determined relevant to the subject. Since the process is transparent all reports are published online. When the benchmark process is completed, it is recognized by the GSSI as formal and public. I.e., The scheme is aligned with the FAO- code of conduct for responsible fisheries, -ecolabelling guidelines for fisheries and aquaculture and -technical guidelines for aquaculture certification for aquaculture. However, GSSI does not declare the scheme sustainable. The last step is to evaluate the environmental, operational and governmental criteria. Another service that GSSI provides is a platform that connects stakeholders and users to share challenges linked to environmental, economical and social sustainability issues within the seafood sector.

4.2. Seafood Fraud and Traceability

According to Lewis & Boyle (2017) seafood fraud or deliberately mislabeling the products or species names has been prevalent in the industry for a long time. The Office of Seafood, a subsidiary agency under the US Food and Drug Administration (FDA) conducted inspections between 1988 to 1997 concluded that approximately 37% of fish species and 13% of other seafood species were mislabeled. Today, the seafood supply chains are more globalized and complex than ever. This creates more opportunities for fraud. Seafood fraud is a major issue in the industry as certain seafoods can cause allergic reactions or other health issues. Furthermore, seafood fraud also encourages illegally caught fish to be brought to the market. To prevent seafood fraud, Governmental agencies and NGOs can conduct DNA tests on the seafood to confirm the species.

Media has also brought human rights abuse of workers in the fishing industry into the spotlight. It is a legitimate concern where fishing and seafood processing has been linked to unethical practices such as hazardous working conditions, human trafficking and low wages (Lewis & Boyle, 2017). These issues are especially apparent in illegal and unregistered vessels fishing but have also been traced to legitimate aquaculture supply chains. Improving and implementing various traceability systems where data about the fishing and processing is collected may help solve the issues.

4.3. The Global Dialogue on Seafood Traceability Summary

The GDST-system uses the EPICS standard to meet the needs of a transparent seafood supply chain. The EPICS system is an event based traceability system where “events” such as the who, what, when and wheres of each activity a product is recorded during its journey to the end consumer. The GDST has identified several Key Data Elements (KDE) and how they should correlate to each specific Critical Tracking Event (CTE). For example as seen in figure 1 and 2, KDE:s include overall vessel data, catch data, transhipment data etc. Whereas the CTE are critical events in the seafood supply chain from fishing to end processing. For the KDE:s and the corresponding CTE:s are not marked with “X”, it means it is not necessary for that KDE to be captured at that specific CTE. For a seafood supply chain to be fully compliant with GDST, all KDE:s must be captured at all the marked and relevant CTE:s within the supply chain as seen in figure 1 and 2.

The seafood supply chain is large and complex, in order to validate the objects, entities, and locations relevant in tracing the seafood products, identifiers are essential components of the EPCIS event-based

traceability system. The GDST requires the use of identifiers for certain objects, entities, and locations. The following types of identifiers are GDST compliant: Universal Unique Identification (UUID) and URLs. Radio Frequency Identifiers (RFID) and Internet of Thing devices (IoT) are also permitted if they comply with the EPICS standard.

Figure 1.

A summary list of KDEs for caught seafood products, grouped into different data types and correlated with the CTEs at which each KDE must be captured (GDST, 2022).

Table W1a – BUL-KDEs(wild) Mapped to Critical Tracking Events (CTEs)

Basic Universal List of Key Data Elements (Wild-capture Products)	CTEs						
	Fishing	On Vessel Processing	Transshipment	Landing	Aggregation/ Disaggregation	Ship/Receive	Processing
VESSEL DATA (master level data)							
Vessel Name	X	X					
Vessel Registration	X	X					
Unique Vessel Identification	X	X					
Public Vessel Registry Hyperlink	X	X					
Vessel Flag	X	X					
Availability of Catch Coordinates	X						
Satellite Vessel Tracking Authority	X						
Transshipment Vessel Name			X				
Transshipment Vessel Unique Vessel ID			X				
Transshipment Vessel Registration			X				
Transshipment Vessel Flag			X				
CATCH DATA							
Catch Area	X						
Fishery Improvement Project	X						
Vessel Trip Dates	X						
Date(s) of Capture	X						
Gear Type	X						
Production Method	X						
TRANSSHIPMENT DATA							
Transshipment Location			X				
Dates of Transshipment			X				
(LANDING DATA							
Landing Location				X			
Dates of Landing				X			
PROCESSING DATA							
Expiry / Production date		X					X
Product Origin		X					X
CERTIFICATIONS AND LICENSES							
Fishing Authorization	X						

Figure 2.

Continuation of Figure 1.

Basic Universal List of Key Data Elements (Wild-capture Products)	CTEs						
	Fishing	On Vessel Processing	Transshipment	Landing	Aggregation/ Disaggregation	Ship/Receive	Processing
Harvest Certification[3]	X						
Chain of Custody Certification		X	X		X	X	X
Transshipment Authorization			X				
Landing Authorization				X			
Existence of Human Welfare Policy	X	X	X	X			X
Human Welfare Policy Standards	X	X	X	X			X
TRACEABLE OBJECT INFORMATION							
Species	X	X	X	X	X	X	X
Product Form	X	X	X	X	X	X	X
Item / SKU / UPC / GTIN	X	X	X	X	X	X	X
Linking KDE (batch, lot or serial number)	X	X	X	X	X	X	X
Weight or Quantity	X	X	X	X	X	X	X
Unit of Measure	X	X	X	X	X	X	X

Table W1b – EPCIS Technical Data for Event Identification[4]

TECHNICAL DATA							
Event ID	X	X	X	X	X	X	X
Event Date, Time & Time Zone	X	X	X	X	X	X	X
Event Read Point (Geo Location)	X	X	X	X	X	X	X
Product Ownership	X	X	X	X	X	X	X
Information Provider	X	X	X	X	X	X	X

4.4. Marine Stewardship Council Standard Traceability Summary

MSC standards are for labeling of fish products. According to the MSC traceability standard, there are five main principles to form this standard, as seen in the list below.

1. Certified products are purchased from certified suppliers;
2. Certified products are identifiable;
3. Certified products are kept separate;
4. Certified products are traceable and volumes are recorded;
5. The company has a management system.

In principle 2, the certified products shall be identified at all stages of the supply chain including purchase, receipt, storage, handling, packaging, labeling, sale and delivery, and shall not be mislabelled. In principle 3, the certified products shall not be mixed and confused in order to be kept separate. In principle 4, the organization shall have a traceability system that can trace back all certified products. The prerequisite is that the traceability documentation should be linked to the certified products, and the information should be accurate, complete and free of alterations. Also, if changes are made to the documentation, the organization should be responsible for maintaining them.

From a supply chain perspective, the MSC traceability standard is developed for the “organizations" like the producers, the suppliers and the retailers. The producers include the fisher and the fish farmer, who are responsible for catching and landing the fish. Suppliers are responsible for processing and distributing the fish, and retailers are responsible for selling the fish to consumers. Every single section requires the traceability between the producers and suppliers, and also the suppliers and the retailers.

4.5. Related E.U. regulations

In E.U. regulations, there also exists many statements of the traceability of food. For example, in Article 18, Regulation (EC) No. 178/2002 (EU, 2004.) It defines traceability as “an ability to trace and follow food, feed, and ingredients through all stages of production, processing and distribution”.To this end, the operators involved shall establish systems and procedures to provide relevant information to the competent authorities upon request. In terms of specific measures, the supplies should be adequately marked or identified in accordance with relevant requirements in order to allow traceability. According to EU (2004) Article 17, Regulation (EC) No. 1935/2004, a similar formulation is adopted, stressing information disclosure and effective measures achieving traceability at all stages.

5. Discussion

This part contains an analysis and reflection of the results section.

5.1. Semantic relationship between the standards

The GSSI is used to benchmark organizations and depending on the result the organization receives a certification (GSSI, n.d.). All information connected to the benchmark process is transparent due to it being uploaded online. GSSI does not create certifications, they simply provide certification of them. One certification body related to GSSI is MSC. Whereas, MSC provides international standards based on the FAO guidelines (Marine Stewardship Council, n.d.). Therefore, semantic interoperability requires updated data in related systems to provide correct evaluation and certification. Furthermore, GSSI also provides a platform to their stakeholders and users to discuss sustainability challenges linked to social, economical and environmental issues within the seafood sector.

The GDST is a platform for ensuring traceability within the seafood industry (GDST, 2022). Similar to the GSSI, GDST does not create its own standards or certifications, they use already established certification bodies such as MSC for guidelines. For its technical guidelines it uses the EPCIS as a standard to track how KDE:s such as vessel data, Catch data and transhipment correspond with CTE:s to the supply chain, e.g., vessel-, catch- and transhipment- data. GDST is used in the seafood sector to showcase transparency within the very global and complex supply chains. For example, if one part of the supply chain lacks sufficient information about the “gear type” used at a relevant CTE, for example fishing. It would mean that the specific supply chain event is not compliant with the GDST. All KDE:s must be captured at all the marked and relevant CTE:s within the supply chain to be fully compliant. Furthermore, GDST has set identification requirements on the supply chain path to control the legitimacy. UUID:s, URL:S and certain EPICS compliant RFID:s and IoT:s are common identifiers used in a GDST compliant supply chain.

5.2. Certifications role in the supply chain

MSC is the only covered organization that provides certifications within the seafood and labeling of fishery products. Therefore, MSC creates standards for producers (fisheries), packaging companies and the retailers.

GSSI's role in the supply chain is to provide a benchmarking service to ensure a sustainable development and protection of the oceans. Furthermore, as GSSI collaborates with several other actors within the seafood sector. These actors are exchanging information and knowledge related to sustainability challenges through the established platform that GSSI provides (GSSI, n.d.). In the figure below are nine certifications that are recognized by GSSI and can be provided through the global benchmarking tool (GSSI, 2021).

Figure 3.
Certifications recognized by GSSI (Adapted and modified from GSSI, 2021).

Note. The above figure shows certifications that are recognized by GSSI. For example, the upper row, middle blue fish labeling is the certification provided by MSC.

The benchmarking tool is relevant for actors within the seafood- and aquaculture- sector that either want to acquire certification or provide certifications. Furthermore, the certification can increase the attractiveness of the products to consumers and therefore it could also be relevant for retailers, to increase sales and ensure satisfied customers.

Finally, GDST provides event traceability connected to activities between transport of the product to the customer. It is a system developed for business to business purposes. The main users of this standard are therefore NGO fishers or fish farmers, processing and packaging units and transport providers who track events connected to transport modes, such as vessels (fishing vessels).

6. Conclusions

Unethical seafood practices have been prevalent in the industry for a long time and raised awareness about the sector. Traceability has helped fight seafood fraud and make the sector more transparent and help advance the sector in regards to the environmental and social issues that the SDG goals bring up. The report looked into three major tools, standards and certifications used in the seafood sector. The Global Dialogue on Seafood Traceability (GDST), Marine Stewardship Council (MSC) and the Global Sustainable Seafood Initiative (GSSI) were analyzed, summarized and reflected upon throughout the report. Neither GDST nor GSSI have their own certification bodies. Instead they comply with already established standardized certification bodies such as the MSC.

GDST is an initiative with the purpose of improving the traceability of seafood products between NGO actors in the entire seafood supply chain and tracks important events. From the date of harvesting the seafood to processing and freezing to display for the end consumer. The system relies on EPICS compliance systems as a technical guideline to achieve its transparent tracking and identification. Specific identification systems accepted by EPICS are: UUID:s, URL:S and certain EPICS compliant RFID:s and IoT:s. Actors in the supply chain that uses the GDST standard are the fishers or fish farmers, processing and packaging units and transporters.

GSSI aims to help organizations in the seafood sector to benchmark and assess their sustainability performance. Organizations use the GSSI global benchmark tool to evaluate their own performance and identify areas where improvements can be made and to enquire certifications as seen in figure 3. If the benchmark is passed the user is formally recognized for seafood certification. GSSIs purpose is to ensure sustainable development within the seafood sector and to protect the oceans for future generations. Furthermore, the organization also provides a platform for stakeholders and connected actors to discuss sustainability problems connected to the seafood industry. The role of GSSI in the supply chain is to provide actors related to aquaculture and the seafood industry with benchmarking to achieve certification. These actors can be producers and retailers.

The MSC sets standards for sustainable seafood traceability and practices. Fishing companies achieve MSC certification by successfully passing assessments such as inspections of the operations and data and documentation reviews. The assessment is made by an independent certification body and includes inspections of the operations and review of data and documentation. MSC is frequently used as a mark for consumers to identify sustainable seafood products. Furthermore, the main customer segments of MSC are the retailers and producers, such as fisheries.

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