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ICT in Business and the Public Sector

From Ship to Shelve – How a Reference Architecture can Support Regulatory Compliance in the Dutch Fisheries Sector

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MASTER'S THESIS

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Abstract

Background: The Dutch fisheries sector faces new challenges with the modernization of the European Union's common fisheries policy. Regulation (EU) 2023/2842 requires mandatory digital traceability throughout the supply chain, forcing organizations to register, manage, and exchange data on catch, processing, and distribution. In practice, issues such as fragmented systems, inconsistent data structures, and low architectural maturity hinder interoperability and complicate compliance. These challenges highlight the need for structured guidance that aligns business processes, information flows, and IT systems across the sector.

Aim: This study seeks to develop a reference architecture that supports Dutch fisheries identify, structure, and align processes, information, and technology necessary to meet current and future regulatory requirements, with a focus on traceability.

Method: A Design Science Research Methodology was followed, combining literature review, document analysis of EU regulations and industry standards, stakeholder analysis, exploratory and in-depth interviews across the supply chain, and expert and industry evaluations. Insights informed the development of an artifact consisting of architecture principles, good practices, four viewpoints and eleven views, and a terminology.

Results: The resulting reference architecture provides a sector-specific blueprint that organizes regulatory drivers, traceability processes, information objects, system interactions, and governance principles. Evaluation by experts indicate that the reference architecture scores highly on clarity, relevance, and overall value for organizational use. Industry evaluation feedback from trade associations confirms its broad applicability within the sector and highlights its usefulness for communication, standardization, and alignment. The findings show that traceability challenges are not purely technical but architectural in nature, requiring harmonization of processes, information, and technology.

Conclusion: The reference architecture supports fisheries by providing structured guidance for regulatory compliance, enhancing interoperability, and enabling coherent decision-making across processes, information, and technology. Beyond its technical utility, it serves as a tool for sector-wide communication and coordination. This work presents the first sector-specific reference architecture for the Dutch fisheries domain and demonstrates its potential for broad adoption. Future work may extend the architecture to other fisheries segments and explore implementation strategies to support long-term institutionalization.

Acknowledgements

I would like to sincerely thank my father for inspiring me to pursue research in the fisheries sector. It has been a wonderful experience to learn from, engage with, and contribute to the work that our family has been involved in for generations.

Contents

Chapter 1

Introduction

The seafood industry supports the livelihoods and food security of billions of people worldwide. Fish caught and farmed by European member states travel the world to reach customers on all continents. In 2023, the European industry exported an amount of €38.2 billion in fisheries and aquaculture products [15] — in that same year, the Dutch industry had an export value of €6.2 billion [3]. From a fleet perspective, the Dutch sector consists of eight large fishing trawlers flying the Dutch flag and over two hundred smaller cutter fishing vessels. In 2023 this fleet caught an estimated total of 261,4 million kilograms of fish, of which fishing trawlers accounted for 209 million kg [3].

For fisheries to operate in the market, they must comply with an extensive set of regulations. Catch limits are determined for EU member states via Total Allowable Catches (TACs), which aim to prevent overfishing for sustainable fish stocks across European waters. In addition, fish processors must comply with food safety regulations such as Hazard Analysis and Critical Control Points (HACCP) to guarantee safe products for consumers.

These regulations exist to ensure a sustainable sector and safe products for all to consume. At the same time, regulations like these also pose challenges to the sector. Fisheries are required to adhere to many and often strict regulations which impact processes, systems and infrastructure that are used during day-to-day operations – which in turn increases the complexity of operations.

1.1 Problem statement

1.1.1 Research Problem

Over the years, the fisheries sector has faced increasingly strict and complex regulatory requirements. This forces fisheries to adapt their processes, systems and infrastructure in order to ensure compliance and operational efficiency. Over the past decades, the common fisheries policy (CFP) - known in Dutch as the Gemeenschappelijk Visserijbeleid (GVB) - [18] has been revised roughly every ten years with major updates or addenda, with the latest update enacted in 2023 under Regulation (EU) 2023/2842. In addition to the CFP, numerous smaller legislations have also been adopted affecting the fisheries sector. In the last two decades, approximately ten major pieces of legislation have been enacted affecting the fisheries sector, ranging from sustainability and market control to technical measures (see Appendix A).

These frequent and evolving regulatory requirements have significant impact on fisheries. A recent regulatory change in regard to traceability of fish products throughout the fisheries supply chain is affecting every involved actor. This requires all actors to record and share detailed product information. In practice, organizations need to be able to register, maintain and exchange information with partners. At this moment, systems are fragmented, inefficient and do not fully capture or share product information across the supply chain [12, 5]. The combination of fragmented systems and a lack of institutionalized standards form a major barrier to interoperability, hindering reliable data exchange between actors throughout the fisheries supply chain [24, 21, 5].

These challenges result in limited interoperability between systems, which in turn limit traceability in the fisheries sector. In addition to regulatory requirements, consumers are increasingly demanding more transparency regarding the origin of the products they purchase [21]. When traceability is insufficient, fisheries may not be able to provide this transparency which can undermine consumer trust.

Being compliant with changing regulations is challenging. The fisheries sector is generally considered conservative, both socially and culturally, with lower levels of innovation and digital literacy [30]. Together with technical barriers, these constraints create obstacles for fisheries trying to meet regulatory compliance ánd provide the transparency that consumers demand. One approach to address these challenges is to introduce enterprise architecture, which provides a structured framework to align business processes, information flows, and IT systems across the supply chain.

1.1.2 Importance

Traceability is not only relevant for the fisheries sector; across food supply chains, regulatory requirements and consumer expectations have evolved significantly. However, traceability specific to the European fisheries sector must be addressed due to regulation by the European Union (EU). Specifically, EU Regulation 2023/2842, which is an overhaul of the CFP EU 1380/2013 to modernize the EU-control system for fisheries [1]. This regulation sharpens rules on monitoring and reporting the traceability of catches through electronic registration. In practice, it requires fisheries to provide traceability information for their products. By January 2026, all fisheries and other actors in the supply chain must comply with traceability standards and be able to show how their products are sourced. For this study, we focus on Articles 56 and 58 of Regulation (EU) 2023/2842, which addresses the traceability control of fisheries products.

In addition to regulatory compliance, improved traceability and transparency also improve supply chain resilience. These factors create a more trustworthy and reliable supply chain, capable of mitigating disruptions in the fisheries operations [37]. Consumers increasingly demand ethically sourced, sustainable and responsibly produced fish. Traceability provides transparency that strengthens consumer trust, while certifications further support responsible sourcing [42]. In the last decade, new technologies such as blockchain and the Internet of Things (IoT) have emerged and demonstrated their value. These innovations can enhance both supply chain resilience and compliance with regulatory requirements [12, 29].

1.1.3 Academic Contribution

This study addresses an underexplored area in the academic literature concerning the governance of traceability at a sector level within the Dutch fisheries sector. While several studies have discussed traceability within fisheries, these studies mainly focus on technological solutions or supply chain transparency. Limited attention has been given to the architectural mechanisms required to align regulatory requirements, organizational processes, information objects and IT systems within this sector. Enterprise architecture literature suggests that reference architectures can function as instruments for coordination and governance in regulated environments. However, their use in the fisheries sector, particularly in a context with limited enterprise architecture maturity, remains insufficiently examined. By investigating the development of a reference architecture for traceability in the Dutch fisheries sector, this study contributes to the understanding of how enterprise architecture concepts can be applied within this specific domain.

Building on this theoretical contribution, the study demonstrates that in such a context a reference architecture can function as a guiding mechanism for organizations. Within the context of the Dutch fisheries sector, a reference architecture provides a conceptual framework that connects processes, information, technology and regulatory requirements.

In addition to these conceptual benefits, a reference architecture addresses practical challenges by guiding organizations which use different technologies with governance principles to ensure consistent application across the sector. In practice, this enables organizations to have a unified understanding of the sector, follow clear guidelines and comply with regulatory requirements more efficiently.

1.2 Research questions

Based on the identified regulatory, technical, and organizational challenges, our research aims to develop a reference architecture that supports traceability across the supply chain of the Dutch fisheries sector.

To achieve this, we have formulated one main research question and four sub-research questions.

The main research question is formulated as:

> **How can a reference architecture support fisheries companies in identifying and aligning the business processes, applications, and IT infrastructure required for compliance with current and future regulatory requirements?**

To operationalize the main research question, four sub-questions are formulated. These sub-questions address the regulatory context, relevant enterprise architecture principles, the design of the reference architecture itself, and its evaluation and applicability across Dutch fisheries companies.

SRQ.1 *What are the current and future regulatory requirements in the Dutch fisheries sector, and how do these requirements affect business processes, applications, and IT infrastructure?*

SRQ.2 *Which enterprise architecture principles and governance mechanisms are relevant to supporting regulatory compliance in Dutch fisheries companies?*

SRQ.3 *Which layers, components, and guidelines should a reference architecture include to support Dutch fisheries companies in complying with regulatory requirements?*

SRQ.4 *Is the reference architecture applicable across Dutch fisheries companies, and to what extent is it generalizable?*

1.3 Thesis Overview

In Chapter 2, we discuss the background of traceability in the fisheries sector and review related work, exploring enterprise and reference architecture concepts as well as supporting theories on adoption and institutionalization of architectures. Chapter 3 covers the methodological approach, introducing the Design Science Research Methodology and explaining its use in developing the reference architecture.

Chapter 4 outlines the design phase of the reference architecture, including the development of architecture principles, viewpoints and views. The evaluation of the reference architecture is covered in Chapter 5, describing how it was applied during the study and the value it provides according to stakeholder feedback.

The results of this study are discussed in Chapter 6 including implications and limitations. Finally, Chapter 7 answers the research questions and presents the contributions of the study, along with suggestions for future work.

Chapter 2

Literature review

This chapter establishes the theoretical and contextual foundation for this study. Given the increasing regulatory pressure for digital traceability in the European fisheries sector, a structured understanding of existing knowledge is necessary to position the research problem, identify conceptual gaps, and justify the proposed design contribution.

The literature review discusses three domains. First, it introduces traceability in the fisheries sector, outlining its regulatory context, core concepts, and current implementation landscape. Second, it presents enterprise architecture (EA) and reference architectures (RAs) as structuring mechanisms. Third, it discusses complementary theoretical perspectives that help explain how architectural solutions create value and become adopted within a sector.

Together, this provides the foundation for addressing the research questions and for motivating the development of a reference architecture for digital traceability in the fisheries sector.

2.1 Traceability in the Fisheries Sector

Due to recent regulatory developments, digital traceability has become mandatory in the European fisheries sector. This section discusses traceability within its regulatory context, outlining the legal foundations, conceptual definitions, and its practical implications. Although traceability has been extensively studied in agro-food supply chains, its implementation in fisheries presents specific technological and interoperability challenges. Traceability does not operate in isolation; it relies on underlying technological infrastructures, data standards, and system architectures, which are examined in this section.

2.1.1 Regulatory Context

In the last decades, a limited number of major reforms and additions to legislation have been made. The core policy of the Common Fisheries Policy (CFP) was defined in 1983. With various revisions over the years, the latest version stems from 2013. However, there has been a recent addition to this regulation about enforcement, EU Regulation 2023/2842. In total, approximately ten major legislations have been implemented affecting the European fisheries sector, ranging from sustainability and market control to technical measures (see Appendix A). These regulations are aimed at fishing companies, but downstream also impact fish processors and retailers.

Specifically EU Regulation 2023/2842, which is the modernized control and enforcement part that enables the CFP to function effectively. This introduces mandatory digital traceability, where fisheries need to keep track of digital logbooks, electronic registration of activities and key data elements used for the traceability of fish products [1]. Key data elements include, but are not limited to, vessel ID, FAO catch area, catch method, catch date and species. This control regulation should lead to consistency, less ambiguity and better interoperability to combat illegal, unreported and unregulated (IUU) fishing activities in the sector.

2.1.2 Concept and Importance of Traceability in Fisheries

Traceability goes beyond regulatory compliance, providing visibility, accountability, and value across the fisheries supply chain. Different definitions of traceability exist. One way it can be defined is as the ability to obtain any or all information relevant to a product throughout its entire life cycle, from capture to consumer, through recorded identifications [49]. Alternatively, traceability is defined as the capability to track and trace the history, application or location of an item by means of recorded information [22]. A final definition is: the ability to track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales [34].

For the fisheries sector, traceability does not exclusively concern physical goods, but also the flow of digital data [12]. The combination of physical products linked to digital data creates transparency for actors in the supply chain. Based on the definitions outlined above, traceability for the fisheries sector can be defined as the ability to track and trace both physical products and their associated digital data throughout the supply chain [49, 22, 34, 12].

Traceability not only contributes to regulatory compliance, but also offers strategic advantages for supply chain actors like vessel owners, fish processors and retailers. Building on the synthesized definition, traceability should enable transparency, accountability, and informed decision-making for stakeholders. Furthermore, traceability supports food safety by enabling organizations to trace batches of products, which is essential for product recalls [12]. Finally, traceability plays a key role in promoting sustainability and combating IUU fishing by providing information on the origin and catch methods of fish products [21, 12]. This, in turn, increases consumer trust and enables access to markets where certification and compliance are required [21].

While traceability offers many advantages, in practice it faces numerous challenges. For one, there are no standardized systems in the fisheries supply chain. Countries and organizations use their own variety of systems which limit interoperability for a truly interconnected supply chain [12]. While there are only a few systems in the Netherlands allowed for Electronic Reporting (ERS) [41]. Related to system fragmentation is a semantic problem. While there is a set of pre-defined values given by the European Union, there is no common data model for the sector that software developers can follow. Ship owners, fish processors and retailers use different terms and standards that blur interpretation and complicate data exchange between systems [21]. This, in turn, leads to flaws in data quality and consistency, as limited interoperability and fuzzy semantic interpretation can cause missing or incorrect data elements that undermine traceability [49]. Lastly, adoption of digital systems is not fully implemented in the (Dutch) fisheries sector. For example, fishing vessels smaller than 12 meters are allowed to register fishing trips and catch registration on paper and register digitally afterwards [38]. The lack of digital skills and resources complicates digital adoption which hinders a fully traceable supply chain [12].

2.1.3 Technological Architectures and Interoperability

The identified challenges point to limitations in the current technological landscape of the fisheries sector. Several initiatives have been started by governmental bodies and both for-profit and non-profit organizations for standardization in the fisheries sector. In the European fisheries sector, there have been some standards developed, however none of these have been fully accepted.

For example, the EU has made legislation that forces fishing vessels and national authorities to use electronic reporting systems (ERS) to record, report, process, store and send data on the landing of fish [16]. As a result, electronic reporting allows national authorities to easily exchange data and cross-check it using the United Nations Fisheries Language for Universal eXchange (UN/FLUX). UN/FLUX enables interoperable electronic exchange of fisheries-related information across organizations and information systems [47]. As of now, this seems to mostly be used in systems internally in the EU and not by the private sector. For the private sector, initiatives like the Global Dialogue on Seafood Traceability (GDST) and PoseiDAT have arised to facility a common language for data generated in the maritime fishing sector.

Due to the absence of an accepted standard data language, systems and data architectures are fragmented throughout the sector. Current traceability efforts in the fisheries sector make use of different technical systems and data architectures, ranging from local registration and monitoring systems, to fully integrated platforms in the supply chain [5, 20]. There is a difference in the level of maturity across fisheries in the sector which only complicates the efforts to standardize in the sector. This becomes more complicated with the use of new technologies. There is a trend in which there is an increase in more advanced technologies used in the operations of the fisheries sector [29] [12], like sensors in fishing nets or automatization in fish batch sampling by automating measurements like weight, length and quality. New technologies support operations, improve traceability data, but also complicate data storage and exchange. New data structures are being developed, but there are no guidelines on how to integrate them into existing data structures.

These technological and interoperability challenges indicate that traceability is not only a regulatory or technological issue, but also an architectural one. Addressing fragmentation in systems, data structures and processes therefore requires a structured architectural perspective. Enterprise architecture can provide such a perspective by offering a holistic overview of organizational processes, information, systems and infrastructure. In practice, organizations can adopt reference architectures to guide the development and structuring of their architectures. This provides a blueprint for integrating processes, systems, infrastructure and data standards in a consistent and coherent way.

2.2 Enterprise and Reference Architectures

To address the fragmentation of systems, data standards and processes identified in the fisheries sector, a structured architectural perspective is required. Enterprise Architecture (EA) provides a structured approach to managing complexity within organizations by aligning strategy, processes, information and technology. In this section, the theoretical foundations of EA are discussed, including its core principles, layered structure and widely used frameworks such as TOGAF and the Zachman Framework. Building upon this, the concept of reference architectures (RAs) is examined as a mechanism to standardize architectural choices and promote interoperability across organizations. Finally, the application of EA and RAs is explored in the context of the fisheries sector, highlighting how architectural structuring can support traceability, data integration and regulatory compliance.

2.2.1 Foundations of Enterprise Architecture

Enterprise Architecture (EA) is a holistic framework that enables organizations to align their business strategy with processes, information technology and resources, providing a structured approach to support decision-making, coordination, and strategic change [4]. This enables organizations to respond with confidence to regulatory, technological and market changes. In practice, the foundation of EA are architecture principles. These principles provide guidelines and standards that organizations follow for decision-making and design choices when designing and implementing new processes and systems [4]. Following these principles, EA structures organizations into layers, which typically include a business layer focused on processes and organizational structure, and an information/data layer, responsible for information management. An application layer covers software applications and systems and a technology layer for the underlying infrastructure and hardware [27, 7].

To put EA into practice, various frameworks have been developed. These frameworks provide structured methods, viewpoints and artifacts to describe and manage organizations in a consistent way. While they differ in scope and focus, most frameworks aim to support alignment between business and IT.

TOGAF

One of the most widely known EA frameworks is TOGAF. At its core, TOGAF provides the Architecture Development Method (ADM) (Figure 2.1), a structured cycle that guides organizations in defining, planning and implementing architectures across business, data, application and technology layers [46]. The ADM not only helps in aligning IT with business needs, but also supports implementation, migration and ongoing architectural changes. TOGAF provides a consistent and repeatable approach to developing enterprise architectures, helping organizations improve coordination, interoperability and governance.

Zachman Framework

The Zachman Framework (Figure 2.2) approaches EA from a different perspective. Instead of a development methodology, it offers an ontology - a matrix used to classify and organize architectural artifacts to describe an enterprise [51]. It structures architectural descriptions from different stakeholder perspectives and architectural aspects, helping organizations with architectural documentation.

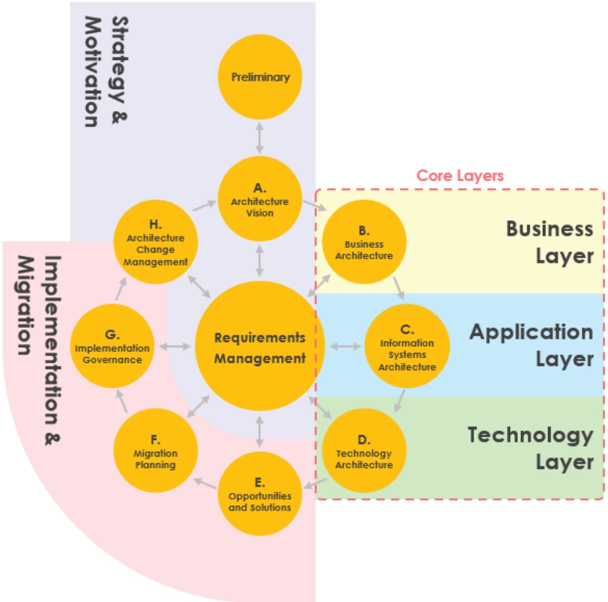

Figure 2.1: TOGAF Architecture Development Method (ADM) [50]

EA contributes to multiple areas in organizations. One of the benefits associated with EA is organizational alignment - the extent to which an organization shares a common understanding of its strategic goals, and collaborate towards achieving these goals [44]. EA provides an overview of operational activities which supports organizations to align strategic goals with their operations. Using this structured overview, EA provides accurate, timely, and relevant information to decision-makers [44]. This reduces information silos and enhances transparency between departments. However, the contribution of EA depends on the organization. The benefits organizations perceive from EA are influenced by the expected role of EA and by evolving trends in the field [48]

Due to regulation, traceability information needs to be present from ship to shelve - covering the primary activities of the fisheries sector, from the catching of fish at sea, the processing of fish products on shore to the distribution and sales to consumers. EA can support traceability by defining the architecture of the fisheries sector through a reference architecture (RA). With this, actors in the sector have a blueprint architecture on which they can base their own processes, systems and infrastructure.

2.2.2 Reference Architectures and Frameworks

One definition of an RA is: a predefined architectural pattern, or set of patterns, possible partially or completely instantiated, designed, and proven for use in particular business and technical contexts, together with supporting artifacts to enable their use [11]. Another way it is defined is as an architecture descriptions that provide a proven template solution when developing or validating an architecture for a particular solution [39] Based on these definitions, a reference architecture can be understood as a predefined and proven architectural template, including supporting artifacts, which guides the development or validation of architectures in specific business or technical contexts [11, 39].

Reference architectures assist organizations in making the right architectural choices. Numerous benefits are linked to RAs. It provides clear standards and guidelines that organizations can follow when developing their own architecture and supporting best practices [39]. RAs also facilitate the communication between technical and non-technical stakeholders. It provides a shared understanding of architectural components that enables alignment between teams [11, 39]. Organizations can leverage RAs as a foundation for their own architecture, avoiding the need to design architecture components from scratch. By adopting a common reference framework, organizations - within the same sector - can achieve greater interoperability, making it easier to exchange information and integrate systems [5, 11].

In general, reference architectures act as best practices and facilitate alignment on architectures for organizations in a particular sector. RAs are widely used across different sectors and industries. For example, the Dutch government provides a reference architecture for all public sector organizations. Nederlandse

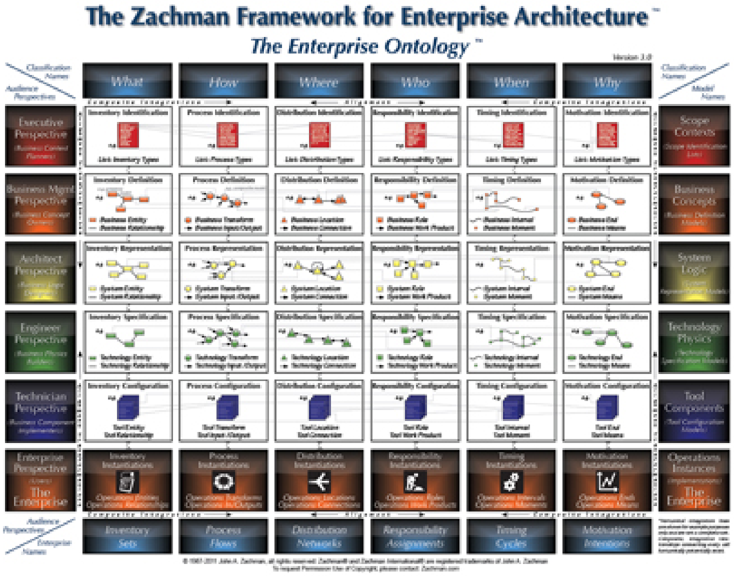

Figure 2.2: The Zachman Framework™ [51]

Overheid Referentie Architectuur (NORA) offers guidelines and a common framework for designing services, systems and processes across government bodies [2]. By following NORA, organizations in the public sector can ensure better interoperability and standardization. In the Dutch education system, reference architectures have been developed for institutions at different levels. The Funderend Onderwijs Referentie Architectuur (FORA) provides guidance for primary and secondary education, while the Hoger Onderwijs Referentie Architectuur (HORA) targets higher education institutions such as universities [43, 26]. Frameworks like these illustrate how reference architectures can standardize processes and systems, promote best practices and facilitate interoperability between organizations in the same field.

The benefits of RAs in other sectors - such as standardization, interoperability and guidance for implementation - are highly relevant to the fisheries sector. The current lack of standardization and interoperability in the sector hinders the effectiveness of traceability initiatives. Using these benefits, RAs can support the adoption and improvement of regulatory traceability requirements [6].

2.2.3 EA in the Fisheries and Data Context

Enterprise architecture has received limited explicit attention in the fisheries sector, which is largely characterized by focus on operational practices and a fragmented supply chain structure. As mentioned above, no RA has been developed, but generic EA frameworks do exist that could be applied to the sector. While the sector is seen as conservative, it does have some architecture. Many fisheries ICT components currently act as an informal - albeit coherent - architecture, such as the integration of vessel monitoring systems (VMS) and electronic reporting systems (ERS) for the provision of logbooks that are automatically shared with governments. This forms an architecture, but without the explicit coherence, governance and principles that are typically associated with architectures. When EA is used in the context of the fisheries sector, it could provide coherent, long-term strategy and better alignment between business, data and IT. Research has been conducted on the development and implementation of interoperability and traceability architectures, including for the fisheries sector [5].

For example, multiple studies have been conducted on traceability systems for the Fast-Moving Consumer Goods (FMCG) field based on blockchain technology. Blockchain offers a transparent and tamper-proof platform that allows catch, processing and distribution information to be traced throughout the sector [35]. Governments and consumers would be able to retrieve reliable data on fish products. On paper this seems ideal, but in practice there are many barriers. Technical complexity, lack of standardization and high implementation costs are among the key reasons why blockchain has not been seen as commercially viable in the fisheries sector [9] [28]. Second, a limited number of data ontologies have been developed and standardized for the fisheries sector. Global fishing grounds have been defined by the Food and Agriculture Organization of the United Nations (FAO) [19], and fish species are globally communicated through their scientific names. Meanwhile vessel classification and fishing gear are grounded in European legislation [17]. These data standards facilitate semantic interoperability, but there has yet to be an institutionalized procedure that exchanges this data between systems. Data for electronic fishery logbooks are automatically gathered through VMS and ERS. Here, data from different systems are integrated into one, which forms an informal architecture. This evolved because of the need for better information provision which has forced systems to integrate with one another in order to achieve a goal.

Enterprise architecture provides a holistic overview of processes, information, systems and infrastructure, enabling organizations to structure and manage their data more effectively. By clarifying how data is collected, stored and shared, EA can support organizations in complying with traceability regulations. Reference architectures extend this by offering architectural guidance and promoting interoperability across organizations within a sector. However, the effectiveness of such architectures ultimately depends on their adoption by sector actors. Architectural solutions only create value when they are implemented and consistently used across organizations.

2.3 Supporting Theories

Developing a reference architecture is not sufficient in itself; its value materializes only when it is adopted, embedded and utilized across the sector. This section introduces the theoretical foundations that help explain how and why architectural solutions become effective in practice. First, theories on technology adoption and acceptance are discussed to understand the conditions under which traceability solutions are embraced by supply chain actors. Second, the interrelated concepts of transparency, traceability and supply chain resilience are examined to clarify their mutual reinforcement and strategic relevance in the fisheries context. Finally, theories on architecture dominance and institutionalization are explored to explain how reference architectures evolve from design artifacts into sector-wide standards.

2.3.1 Adoption and Technology Acceptance

Innovation in the fisheries sector is often regulatory-driven instead of opportunity-driven [14]. Traceability systems in the agro-food and fisheries sectors only provide value when organizations adopt them effectively [32]. Without proper adoption, there is no reliable dataflow, which is necessary for the possibility of traceability. Traceability only adds value when all actors in the supply chain participate and provide information on time and in a correct manner [30]. As a result, adoption problems of traceability systems can lead to gaps, unreliability and non-compliance for organizations. Therefore, effective adoption by all actors in the supply chain is a prerequisite for the implementation of sector-wide traceability solutions [30, 6].

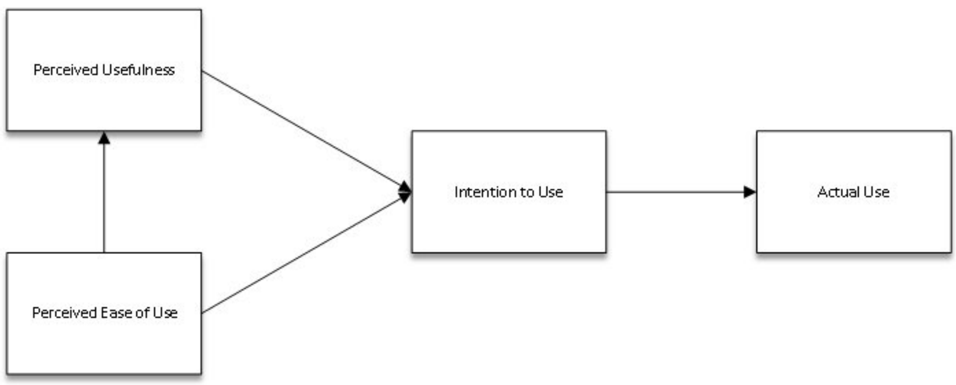

Figure 2.3: Technology Acceptance Model (TAM) [31]

To understand how new technologies are adopted by organizations, the Technology Acceptance Model (TAM) can be used. TAM explains technology adoption by arguing that two user perceptions - Perceived Usefulness and Perceived Ease of Use - directly shape a person's intention to use a system and ultimately their actual usage (Figure 2.3) [13]. Additional factors such as Technology Readiness have been shown to also influence a person's intention to use a new system [10].

TAM is also applicable to the fisheries sector. However, additional factors also play a role in considering adoption. Variables such as norms and trust contribute to the adoption of generic new digital systems [32]. Norms and trust shape user perceptions and expectations, making individuals more willing to adopt digital systems when they feel social pressure to comply or trust that the system is reliable and secure. Technology Readiness (TR) theory can also be included in TAM. When TR is included, factors such as optimism, innovation and perceived risk contribute to traceability solutions [28]. Individuals with greater optimism and innovativeness are more willing to try new technologies, while perceived risk can hinder adoption if users fear negative outcomes. In the context of the Dutch fisheries sector, the aforementioned factors are no surprise. As it is stereotypically seen as a digitally limited skilled sector, where perceived ease of use plays a major factor [30, 32]

A reference architecture can support adoption by simplifying system choices and providing standardized guidelines. This increases perceived usefulness and ease of use, builds trust in the system, and reduces perceived risk.

2.3.2 Transparency, Traceability and Resilience Concepts

Transparency, traceability and resilience are key concepts in this study - forming the foundation of effective supply chains. In this context, transparency is the visibility and disclosure of sustainable supply chain information between actors within and outside the supply chain [42]. Whereas the earlier synthesized definition of traceability is the ability to track and trace both physical products and their associated digital data throughout the supply chain [49, 22, 34, 12]. Lastly, supply chain resilience is defined as an operational capability that enables an organization to prepare for, respond to and recover from a disruption and return to its normal operations' capacity [8].

Transparency offers the information foundation on which traceability is built [40, 42]. When information is openly available, organizations can respond more quickly to disruptions in the supply chain, which in turn creates stronger resilience [37]. Both transparency and traceability contribute to a resilience in supply chains. Supply chains can better respond to disruptions when information is available [37]. For the fisheries sector, transparency and traceability facilitate the power to combat illegal, unreported and unregulated (IUU) fishing activities. When information is readily available in the sector, organizations are more capable to detect when fish products are not legally acquired. Enterprise architecture and interoperable architectures support this by facilitating transparency by being able to share traceability data between multiple stakeholders [37].

However, there are also disadvantages when it comes to traceability. For one, increased costs are expected in relation to the implementation, upkeep and maintenance of traceability systems – whether integrated into existing systems, or implemented as new solutions [42]. Privacy is also a concern, as traceability systems may expose market-sensitive information or other confidential data to unintended parties, potentially affecting competitive advantage or compliance.

By designing a reference architecture that takes traceability and transparency into account, the fisheries supply chain resilience can be increased and at the same time help fisheries provide guidance for regulatory compliance.

2.3.3 Architecture Dominance and Institutionalization

Reference architectures do not just become a standard for an industry. There are numerous factors that determine the dominance of an RA. One of them being the clear and straightforward value it provides, and the willingness of potential users to adopt it [39], which help it become institutionalized when widely adopted across organizations.

An architecture becomes dominant when organizations in a sector use and implement said architecture [39]. Afterward, architectures become institutionalized. Institutionalization refers to the process by which a social arrangement or practice becomes established as a recognized and accepted part of a society or organization [25]. An architecture becomes the standard to which organizations refer. Some aspects of fisheries are institutionalized by the Dutch government, i.e. the way ships need to record their fishing trips and activities [41]. Reference architectures contribute to institutionalization by providing a common language, reusable models and a governance structure for guidance [39]. Having an institutionalized RA also brings risks, such as lock-in, lack of innovation and a suppression of alternatives. Therefore, architecture principles must provide sufficient flexibility as to not obstruct innovation for organizations [23].

Chapter 3

Method

3.1 Methodology

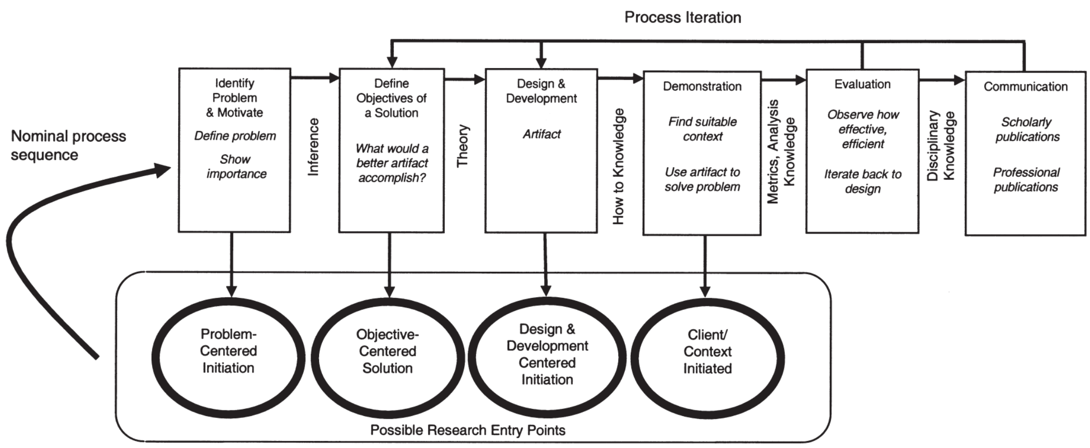

Figure 3.1: Design Science Research Methodology (DSRM) Process according to Peffers et al. [36]

During this study, the Design Science Research (DSR) approach of Peffers et al. has been followed as seen in Figure 3.1 [36]. DSR focuses on the iterative creation and evaluation of artifacts designed to address clearly defined problems in practice. The DSR methodology follows a structured approach that includes problem identification, defining objectives, design and development, demonstration, evaluation, and communication of results. DSR is appropriate in this study to achieve the aim of this study, which is to design and evaluate a reference architecture in the Dutch fisheries sector. This approach provides a structured and iterative process for developing an artifact that addresses a clearly defined problem while based on scientific knowledge. The artifact designed for this study is a reference architecture consisting of architecture principles, good practices, viewpoints, views and a terminology. Principles guide organizations on what they should achieve, while good practices provide guidance on how these objectives can be met. The viewpoints define various scopes of the Dutch fisheries sector and the concerns that needed to be addressed, which are used then used to create views that are worthy for fisheries to see and possible follow. A glossary of terminology is provided as a reference for the reader.

Following the DSR methodology as seen in Figure 3.1, our study started with problem identification and motivation. This phase started with the Problem Statement in Chapter 1 as well as the Literature Review in Chapter 2. This phase was informed by a combination of academic literature and early exploratory interviews with stakeholders across the fisheries sector. Both sources indicate that the sector is facing an increasing regulatory burden, while at the same time exhibiting a relatively low level of architectural maturity. As a result, organizations within the sector often struggle to translate regulatory requirements into timely and coherent solutions. A recent example is the implementation of traceability regulations, where fisheries attempt to achieve compliance in organization-specific ways, as the regulations themselves provide limited guidance on their practical implications.

Following the identification and motivation of the problem, the objectives of the solution were formulated in line with the DSR methodology. These objectives were derived from a combination of insights obtained through exploratory interviews with stakeholders across the fisheries sector and information from the literature review. This dual approach ensured that the objectives were both practically relevant and grounded in existing scientific knowledge.

Based on the established theoretical foundation and the insights gathered from exploratory interviews, the design and development of the artifact were conducted in line with the DSR methodology. The complete design and development of the artifact is discussed in Chapter 4. Architecture principles, good practices, viewpoints and views were derived from literature and observations and contextualized using interview data to reflect sector-specific priorities and context within the Dutch fisheries sector. By providing guidance at a conceptual level and avoiding technical prescriptions, the reference architecture is suitable for a sector with relatively low architectural maturity.

Following the DSR methodology, the artifact was first demonstrated and afterwards evaluated. The demonstration consisted of structured sessions with experts from across the fisheries sector, in which the reference architecture was presented and discussed in the context of the research. The purpose of these sessions was to assess the practical applicability of the artifact and to gather initial feedback from domain experts. The evaluation of the artifact was conducted through questionnaires held after the demonstration sessions. Quantitative and qualitative data were collected to assess the validity and perceived usefulness of the reference architecture. The questionnaires were structured using several evaluation constructs inspired by the Technology Acceptance Model (TAM), as discussed in Chapter 2. These constructs were adapted to reflect the conceptual nature of a reference architecture and focused on suitability, relevance, usability, completeness, and applicability.

Finally, the artifact and its underlying research were communicated through a presentation delivered to participants and representatives from the fisheries sector. During this session, the research methodology, key findings, and the implications of the reference architecture were discussed, along with directions for future work.

3.2 Data Collection

During our study we gathered multiple types of data from different sources, ranging from collecting written works to conducting interviews with experts across the fisheries sector. These sources cover the foundation, but also the depth needed for input of the development of the reference architecture. This section outlines the data sources used in the study.

3.2.1 Document Analysis

A document analysis was conducted to investigate regulatory requirements originating from European regulations. In addition to regulation, industry standards and existing enterprise and reference architecture frameworks were analyzed to provide input for the design of the artifact.

For the analysis, three categories of documents were defined:

- **Regulation and Policy Documents**; European and national laws relevant to the fisheries sector, providing requirements and constraints
- **Sector Standards and Technical Specifications**; industry norms and technical guidelines
- **Enterprise and Reference Architecture Frameworks**; pre-existing frameworks offering best practices for structuring processes, data, and technology

The objective of the document analysis was to identify requirements, constraints, and standardized data elements that would support the design of the reference architecture, while also providing a theoretical and practical foundation for the study. A complete overview of the analyzed documents is provided Appendix B

For the document analysis, all relevant documents were systematically collected. Each document was scanned to extract relevant requirements, constraints, institutionalized data elements, and process information that could inform the design of the reference architecture. The documents were then categorized into the three predefined groups to maintain structure and facilitate analysis. Although no formal method was strictly followed, this structured approach ensured that all relevant sources were considered and that the extracted information provided a solid theoretical and practical foundation for the artifact.

The documents analyzed provided insights into regulatory requirements, industry standards, and best practices, forming the foundation for defining the design requirements of the reference architecture. This data was crucial for ensuring that the artifact is aligned with both theoretical frameworks and practical constraints within the fisheries sector.

3.2.2 Stakeholder Analysis

A preliminary stakeholder analysis was first conducted based on existing documentation and sector knowledge. This initial mapping helped identify key roles and actors across the Dutch fisheries sector and was used to select participants for the exploratory interviews. Stakeholders were then further identified and refined using both direct engagement with experts and insights gathered from the exploratory interviews. These stakeholders were selected because of their direct involvement in operational, regulatory, technological, or managerial aspects of the sector. Including information from the exploratory interviews ensured that stakeholders with differing roles, responsibilities, and perspectives were accurately represented, providing a comprehensive view of the sector and supporting the selection of participants for subsequent interviews and evaluations.

Data for the stakeholder analysis was collected by identifying stakeholders and gathering contextual information about their roles, responsibilities, and influence within the sector. This information was obtained primarily through exploratory interviews. These insights allowed us to determine which stakeholders were critical for participation in the design and evaluation phases of the study, understanding what their interests, concerns, and priorities may be. This information formed the basis for stakeholder mapping and analysis using the Stakeholder Salience Model. It also guided the selection of participants for in-depth and evaluation interviews, ensuring that perspectives from all critical domains of the sector were considered in the development and validation of the reference architecture.

3.2.3 Exploratory Interviews

Exploratory interviews were conducted with experts across different parts of the Dutch fisheries sector to gain contextual and practical insights into day-to-day operations. Participants were initially identified through a preliminary stakeholder analysis, based on existing documentation and sector knowledge. This ensured coverage across the main parts of the fisheries supply chain.

The purpose of these interviews were primarily for fact-finding and contextualization, providing familiarity with the sector. Although the experts may not be involved in every process within the sector, their knowledge provided valuable input for understanding the sector and informed the design of subsequent research steps.

Table 3.1: List of Conducted Exploratory Interviews with Experts

Domain	**Participants Role**
Vessel Operations	Captain, Officer, Machinist, Quality Manager, Fleet Manager
Fish Processing	Logistics Manager, Production Manager, Fish Processor
Office	Procurement, IT-Manager, Legal Counselor, Sales Manager, Export, BI-Specialist, Technical Director, Sustainability Advisor

Exploratory data was collected through unstructured interviews across three main domains of the fisheries sector – vessel operations, fish processing, and office functions – covering a variety of roles, as shown in Table 3.1. Unstructured interviews were chosen to allow flexibility in exploring operational practices, sector-specific terminology, and practical challenges, rather than following a set questionnaire. Interviews were held face-to-face in an informal setting. Notes were taken during each session and later summarized to support contextual understanding and inform the scope of subsequent research activities.

The data obtained from the exploratory interviews provided a contextual understanding of how activities within the fisheries sector are organized in practice. These insights helped to identify key processes, data, technology, and interactions between different actors. The exploratory data helped to better define the problem scope and identify relevant requirements by revealing practical operational aspects and sector-specific concerns. In this way, the interviews complemented the document and stakeholder analyses by adding a practical perspective to the research.

3.2.4 In-depth Interviews

With the help of a stakeholder analysis, key stakeholders were identified across the fisheries supply chain – from ship to shelf. These stakeholders represent different stages of the supply chain and have direct responsibilities related to the generation, processing, reporting, and compliance of traceability data, or provide supporting functions in traceability processes. These stakeholder are:

- **Vessel Officer**; responsible for operational data generation at sea
- **Fish Processor Manager**; overseeing processing activities and product transformation
- **Sales Manager**; responsible for commercial transactions and export-related information
- **IT-manager**; involved in information systems supporting traceability
- **Legal Advisor**; responsible for regulatory interpretation and compliance

For data collection, semi-structured interviews were conducted. Prior to each interview, participants were given a short introductory presentation to familiarize them with the scope and context of the research, the purpose of the interview, and to refresh key concepts related to regulation and traceability. The interviews were conducted face-to-face and lasted approximately twenty minutes on average. A semi-structured interview format was chosen because it provided a clear guiding structure while allowing flexibility to explore unexpected or role-specific insights in greater depth.

Table 3.3: Interview Themes

Theme	**Rationale**
Legislation and Regulation	To understand the legal framework and compliance requirements that influence practices across the supply chain
Business Processes	To capture how fish moves from ship to shelf and the operational practices involved
Applications	To identify software systems used to support traceability and information management
IT-Infrastructure	To examine the technical environment supporting applications, data storage, and system integration
Experiences and Expectations	To gather insights on practical challenges, opportunities for improvement, and stakeholder perspectives on future developments

During the interviews, three to five themes were discussed, depending on the participant's role and area of expertise. The interview themes are presented in Table 3.3. Themes related to applications and IT infrastructure were discarded when they were not relevant to the participant's responsibilities, in order to keep the interview focused. For each of the themes one main question was formulated, supported by multiple probing questions to clarify, contextualize, or deepen the responses. All interviews were recorded and subsequently transcribed to enable systematic analysis. An overview of the themes and questions asked per participant is available in Appendix C.

The data collected through the semi-structured interviews provided in-depth insights into the processes, systems, and infrastructure used to realize traceability across the fisheries supply chain. In addition, the interviews offered a detailed understanding of how traceability-related regulation impacts different actors and stages within the sector.

These insights complemented existing literature by capturing practical, experience-based knowledge that cannot be derived from regulatory documents or academic sources alone. As such, the data contributed to a more nuanced and realistic understanding of operational practices and sector-specific challenges.

The interview data directly supported the development of the reference architecture by informing the identification of relevant architectural components, relationships, and constraints. Furthermore, it provided a foundation for validating the artifact with stakeholders by reflecting real-world perspectives and highlighting similarities and differences across roles and organizational functions within the fisheries sector.

3.2.5 Evaluation Interviews

The evaluation of the artifact was conducted using a structured questionnaire, designed to collect quantitative and qualitative data across six constructs. The questionnaire was inspired by the Technology Acceptance Model (TAM), providing a framework to assess the reference architecture's relevance, clarity, completeness, and practical applicability within the fisheries sector.

For the expert evaluations, participants were selected for their senior-level experience, in-depth knowledge, and objectivity. Experts were chosen to represent different domains within the fisheries sector, ensuring diverse perspectives on the artifact's applicability and usefulness. This selection ensured that feedback reflected both technical and operational considerations relevant to the design and validation of the reference architecture.

Evaluation interviews were conducted to collect feedback and validate the reference architecture. Two types of evaluation were performed; expert evaluations and industry evaluations. Expert evaluations were conducted to gather input on the relevance, clarity, and practical applicability of the reference architecture. Industry evaluations focused on assessing the overall relevance and value of the reference architecture at the sector level, considering its applicability across organizations in the fisheries sector.

Table 3.4: Overview of Interviewed Experts

Expert	**Description**
Visfederatie	Representative of the Dutch fisheries association, contributing sector-level perspectives on regulation and coordination
Redersvereniging voor de Zeevisserij (RVZ)	Policy advisor involved in pelagic fisheries governance and sector representation
Vessel Officer	Onboard officer providing practical knowledge from vessel operations
Pelagic Fleet Manager A	Fleet manager overseeing coordination between vessels and processing activities
Pelagic Fleet Manager B	Fleet manager overseeing coordination between vessels and processing activities
Fish Processing Manager	Fish processing specialist providing insight into production workflows and traceability implementation
IT-Manager	Responsible for digital systems and technical infrastructure supporting operations and traceability
Legal Counselor	Provides expertise on regulatory frameworks, compliance, and legal requirements
Sustainability Counselor	Focuses on responsible fisheries practices, sustainability, and compliance
Sales Manager	Offers insights into commercial processes and customer requirements
Export Employee	Provides perspectives on international trade, documentation, and export procedures

Participants were selected based on insights from the stakeholder analysis. A complete overview of the participants interviewed during the evaluation interviews is provided in Table 3.4. For the expert evaluation, participants were selected based on their senior-level experience, extensive domain knowledge, and objectivity. Experts were deliberately chosen to represent different areas within the fisheries sector, ensuring that feedback covered diverse perspectives on the artifact's relevance, clarity, and practical applicability. For the industry evaluation, participants were representatives of trade associations within the fisheries sector, selected based on the stakeholder analysis. These organizations play a central role in representing sector-wide interests and coordinating between governmental bodies and private organizations. Their involvement ensured that the evaluation reflected a sector-level perspective on the relevance and applicability of the reference architecture.

The evaluation of the artifact was conducted using a questionnaire, collecting quantitative and qualitative data in different constructs. The questionnaire was structured and inspired by the Technology Acceptance Model (TAM), which provides a framework for assessing the relevance, clarity, completeness, and practical applicability of the reference architecture's within the fisheries sector. Quantitative data was collected using a Likert scale ranging from 1 (not at all) to 5 (fully). In addition, qualitative data was gathered through open-ended questions for each construct, allowing participants to elaborate on their ratings and provide suggestions for improvement.

The data collected from the evaluation interviews was essential for validating the reference architecture and ensuring its practical relevance within the fisheries sector. Quantitative feedback provided insights into the perceived clarity, completeness, and applicability of the artifact, while qualitative responses offered detailed suggestions for improvement. By involving both domain experts and sector representatives, the evaluation captured diverse perspectives, supporting iterative refinement of the architecture and demonstrating its usefulness from both technical and sector-wide standpoints. This approach also aligns with Design Science Research principles, demonstrating the artifact's practical applicability in addition to its theoretical soundness.

3.3 Data Analysis

This section describes how the collected data was analyzed and translated into input for the development of the reference architecture. The analysis focused on identifying key themes, stakeholder concerns, and patterns within the fisheries supply chain. The results were then used to inform the structure and content of the architecture viewpoints and the architecture principles.

3.3.1 Document Analysis Results

A structured document analysis was performed to extract relevant regulatory, organizational, and technical elements for the development of the reference architecture. Collected documents were reviewed with a focus on identifying architectural principles, best practices, regulatory requirements, and elements relevant to the development of viewpoints and views. Rather than applying a formal coding scheme, relevant passages were systematically interpreted in terms of their architectural implications and synthesized into architectural building blocks and design requirements.

As shown in Figure 3.2, the 18 documents collected for the analysis fall into three categories: 5 regulatory documents outlining traceability rules and other compliance requirements, 9 industry standards specifying standardized data structures, codes and identifiers, and 4 enterprise and reference architecture frameworks providing architecture principles and reference modelling guidelines.

The analysis resulted in several key outputs. For one, it provided an overview of regulatory constraints that influence traceability design, identified mandatory information flows and the reporting systems, and offered insights into existing sector standards, including institutionalized data elements and data structures. Additionally, the analysis gathered architectural requirements that informed the structuring and scoping of the reference architecture.

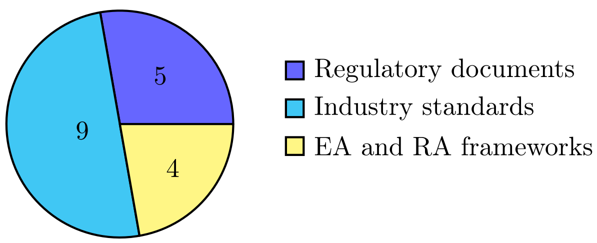

Figure 3.2: Distribution of document types

Table 3.5: Design Input from Document Analysis

Category	Input for design
Regulatory Constraints	Derived mandatory requirements and compliance obligations from European and national regulations that the reference architecture must adhere to
Information Flows & Reporting Systems	Insights into how data moves across the supply chain, including reporting requirements, traceability obligations
Sector Standards & Data Structures	Guidance on industry norms, technical specifications, and structured data models
Architectural Requirements	Best practices and structural guidance from existing enterprise and reference architecture frameworks to inform the design of viewpoints and views in the reference architecture

This resulted in input for the design of the reference architecture. The insights from the document analysis were particularly useful for defining architectural principles and good practices, as well as for structuring the viewpoints and views of the architecture. An overview of the categories and specific input elements is shown in Table 3.5.

3.3.2 Stakeholder Analysis Results

The purpose of the stakeholder analysis was to determine stakeholders in the fisheries sector, their interests and concerns, and to inform the design and evaluation of the reference architecture. Initially, a preliminary stakeholder mapping was conducted to guide the selection of participants for exploratory interviews. Insights gained from these interviews were then used to refine and validate this mapping, ensuring an accurate representation of stakeholder roles, responsibilities, and perspectives across the sector. The formal stakeholder analysis was performed using the Stakeholder Salience Model by Mitchell et al. [33], which categorizes stakeholders based on three attributes:

- **Power**; the ability to influence the sector or decisions
- **Legitimacy**; the appropriateness of their involvement given their role or responsibilities
- **Urgency**; the priority of their needs or claims

Each stakeholder was assessed against these three attributes using qualitative data collected from exploratory interviews and expert engagement. This resulted in a categorization of stakeholders according to their relative salience within the Dutch fisheries sector.

The stakeholder analysis resulted in the following outcomes:

- **Key stakeholders**; an overview of key stakeholders active in the Dutch fisheries sector, categorized according to their salience attributes
- **Stakeholder engagement**; insight into stakeholder engagement needs, supporting decisions on which stakeholders needed to be closely involved, informed, or monitored during the research
- **Stakeholder interests and concerns**; defined at three levels:
  - ***Goal interests*** reflect the objectives and desired outcomes stakeholders pursue within the fisheries sector.
  - ***Protective interests*** relate to risk mitigation, compliance, and safeguarding organizational or sectoral responsibilities.
  - ***Operational interests*** concern day-to-day activities, information needs, and practical constraints in operations.

The stakeholder analysis provided essential input for the reference architecture. First, it identified the most important stakeholders and indicated how they should be involved or kept informed during the research and evaluation. Second, the defined interests and concerns of stakeholders were used to shape the viewpoints in the architecture, ensuring that it reflects both practical needs and priorities across the fisheries sector.

3.3.3 Exploratory Interview Results

Notes and observations from the exploratory interviews were reviewed and organized into segments related to business processes, information flows, application usage, and infrastructure elements. An informal, iterative approach was used to gather and analyze the data, allowing for the identification of key elements relevant to traceability and organizational operations.

The exploratory interviews provided several key insights that informed the understanding of the fisheries sector. They enabled the creation of an informal architecture overview, highlighting the main elements of day-to-day business operations. Additionally, they helped identify participant roles and functions, which later contributed to the stakeholder analysis. Specifically, the interviews provided:

- Familiarity with the sector's core activities and processes
- High-level insights into existing traceability practices and information-sharing procedures
- Identification of operational challenges related data flows and reporting
- Understanding of stakeholder roles and functions, used to guide the stakeholder analysis

The insights provided input for the development of the reference architecture. Specifically:

- **Business Processes**; understanding core operations
- **Information Flows**; identifying key data exchanges and reporting practices
- **Systems and Infrastructure**; mapping existing systems and technology
- **Operational Challenges**; highlighting practical constraints and issues to consider in the design

Overall, these findings provided a contextual foundation that informed the selection of viewpoints, the structuring of architectural elements, and the identification of requirements for the reference architecture.

3.3.4 In-depth Interview Results

The in-depth interview data was analyzed using a thematic analysis approach. Both deductive and inductive coding were applied; deductive based on the predefined interview themes (as seen in Table 3.3), and inductive allowing new themes to emerge from the data. The transcribed interviews were reviewed and relevant fragments were extracted. These fragments were coded and subsequently grouped into themes. The identified themes were then clustered into higher-level categories, consisting of a primary theme supported by one or more related sub-themes.

After analyzing all interviews, the resulting themes were compared and combined across participants. The final clusters were used to structure and categorize potential architecture viewpoints. In combination with identified stakeholder concerns, these clusters formed the analytical basis for the development of the viewpoints within the reference architecture. A detailed overview of the codes assigned to each participant can be found in Appendix D Table D.1, Table D.2 presents the grouping of themes into higher-level clusters.

The in-depth interviews provided a detailed description of the operational and organizational processes in the fisheries sector, including both primary and supporting activities. Similarly, information objects, data flows, and technology used across the sector was identified.

Insights into personal experiences, expectations, and concerns of stakeholders were also collected, highlighting what experts consider important or problematic regarding regulation and traceability. Relevant fragments from the interviews were coded and grouped into themes. These themes were then combined into clusters, each containing a primary theme supported by one or more secondary themes. An overview of these clusters can be seen in Figure 3.3.

The interview participants provided practical descriptions of the processes, information, systems, and technology active in the fisheries sector. These insights helped determine which elements should be included in the views for each architecture viewpoint.

Stakeholders personal experiences and perspectives were used to prioritize elements during the development of the viewpoints, supporting decisions on what is most important in practice. They also informed specific design choices.

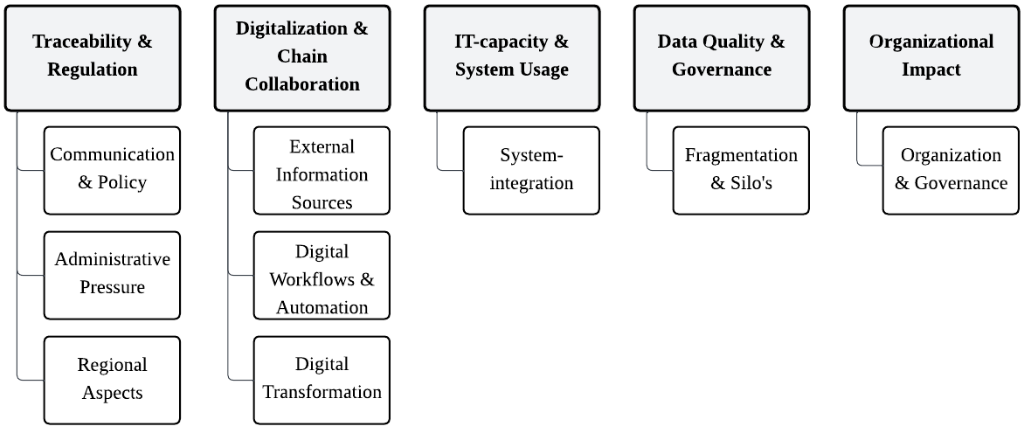

Figure 3.3: Clusters Containing Primary and Supporting Themes from Interviews

The clusters derived from the interviews were combined with stakeholder concerns from the stakeholder analysis to guide the design of the architecture viewpoints. Primary themes framed the main structure of each viewpoint, while secondary themes enriched the viewpoints with additional context and relevant details.

3.3.5 Evaluation Interview Results

In this subsection we summarize the main findings of the evaluation interview and their role as input for refining the reference architecture. A detailed discussion of the evaluation results, including quantitative scores and qualitative feedback, is presented in Chapter 5.

The data collected through the evaluation interviews included both quantitative and qualitative responses. Quantitative data from the structured questionnaires were summarized as average scores per evaluation construct. Qualitative feedback was analyzed to identify recurring patterns, observations, and suggestions. Relevant fragments were grouped into four main categories, representing key themes emerging from the participants' responses.

The analysis provided insights into participants' perceptions of the reference architecture. Quantitative results showed how the artifact was rated across constructs such as relevance, clarity, completeness, and practical applicability. Qualitative feedback highlighted perceived sector value, structure and visualization, suggestions for improvement, and potential implementation challenges. Differences and similarities between expert and industry perspectives became clear, offering a nuanced understanding of the artifact's reception.

Overall, the evaluation interviews served as validation of the reference architecture. Quantitative scores helped identify constructs that were well received and those that required additional attention. Qualitative themes provided guidance for refinement, improving the coherence, relevance, and practical usability of the artifact. Together, these insights ensured that the reference architecture aligns with sector needs and reflects the perspectives of both domain experts and industry stakeholders.

Chapter 4

Design

In Chapter 1 we introduced the idea of developing a reference architecture for the Dutch fisheries sector. In this chapter, we discuss the design and development of said reference architecture, going over the three parts which this artifact consists of.

4.1 Artifact Overview

In Chapter 2 we defined a reference architecture as a predefined and proven architectural template, including supporting artifacts, which guides the development or validation of architectures in specific business or technical contexts [11, 39]. This supports designers as well as decision-makers in managing and understanding complex architectures. Other benefits include structured guidance and established best practices, promoting standardization and reducing the need for customization. By offering a common architectural foundation, organizations within the fisheries sector can use the reference architecture as a basis for the development or validation of their own architectures, facilitating alignment and consistency across the sector.

In line with the Design Science Research approach, this study resulted in the development of an artifact, a reference architecture This reference architecture is composed of three elements that together support architectural decision-making within the sector.

1. **Architecture Principles and Good Practices**; providing guidance on what organizations should do and how this can be achieved in practice
2. **Viewpoints and Views**; defining the perspective and focus of architectural analyses, including the corresponding representations
3. **Terminology**; providing an overview of key terms and definitions related to the reference architecture and the fisheries sector

4.2 Architecture principles and Good Practices

Architecture principles form the foundation of enterprise architecture [4]. They provide guidance for organizations by defining what should be achieved across various architectural domains. Good practices complement these principles by offering practical guidance on how organizations can realize and operationalize them in practice. These architecture principles and good practices provide the foundation for a reference architecture. They define the architectural direction and provide guidance for organizations within the sector. By guiding design decisions related to processes, data and technology, these principles and good practices support governance and implementation. This reduces the need for organizations to start from scratch when making architectural decisions. When applied consistently across the sector, principles and good practices address sector-wide challenges such as fragmentation, inconsistency and compliance. Shared adoption promotes alignment in architectural choices, processes, data and technology across organizations.

Within the reference architecture, architecture principles and good practices serve to translate architectural knowledge into actionable guidance. Rather than redefining architectural direction, these elements operationalize the reference architecture by supporting organizations in making consistent design and implementation decisions.

4.2.1 Design Decisions

While architecture principles form the foundation of enterprise architecture [4], good practices are not always included. As discussed in Chapter 2, the fisheries sector is relatively conservative, digitally challenged, and demonstrates low architectural maturity. In this context, principles alone may be too abstract to be fully understood or applied. Good practices complement principles by providing concrete guidance, enabling organizations to implement and follow the principles effectively. Good practices operationalize the architecture principles, translating abstract guidelines into actionable steps. The two elements are complementary: principles provide strategic direction, while good practices offer practical implementation guidance. Without principles, good practices risk being isolated actions lacking coherence; without good practices, principles remain abstract and difficult to implement.

The design of the architecture principles and good practices was informed by multiple sources analyzed in this study, including document analysis and interview data, providing both sector-specific insights and general guidance for the fisheries sector. Existing frameworks, such as TOGAF and NORA, were analyzed as part of the document analysis to identify common, sector-independent architecture principles. These frameworks provide established generic principles that are fundamental for enterprise architecture, offering guidance that can be adapted to the fisheries sector. Insights from exploratory and in-depth interviews were identified through thematic analysis of the interviews and used to identify recurring challenges and gaps in the sector. These findings informed the formulation of principles and good practices that address concrete problems, such as gaps in regulatory compliance or inconsistent architectural approaches. Relevant laws and regulations, including those related to cybersecurity and data management, were examined in the document analysis and informed specific principles and good practices. Regulatory requirements were used as inspiration for principles that ensure organizational alignment with legal and compliance standards.

4.2.2 Product Description

The reference architecture consists of a structured set of architecture principles, each complemented by one or more good practices. Together, these elements provide guidance and practical direction for organizations operating in the fisheries sector. The principles and good practices follow a consistent structure and are grouped into domains that cover the different layers of enterprise architecture.

A complete list of the architecture principles is shown in Appendix E and good practices is shown in Appendix F. In total, four architecture principles were designed accompanied by eleven good practices. These are documented in a standardized template. Documentation of the architecture principles and good practices is included in Appendix G

Table 4.1 shows an example of an architecture principle. Each architecture principle contains a statement, rationale, implications, domain, possible relation to regulation and source. Table 4.2 shows a good practices related to the principle shown above. Each good practice is linked to a principle and includes a name, description, expected impact, and source.

The architecture principles are intended to be used as guiding statements that inform decision-making, while the accompanying good practices support organizations in translating these principles into concrete actions. The principles and good practices can be applied at multiple moments within an organization. For one, during design activities to guide architectural related decisions. But also during evaluation to asses existing processes, data or technology. Lastly, with governance to support consistency, compliance and long-term alignment.

The principles and good practices provide guidance and operational direction, but do not constitute a full enterprise architecture or technical blueprint. They are intended as reference material to support consistent decision-making and implementation in the fisheries sector.

Within the reference architecture, principles provide the foundation, while good practices operationalize these principles to support implementation. These elements are intended for multiple stakeholder groups,

Table 4.1: Architecture Principle Example

Principle	Proactive compliance
Statement	Organizations should ensure they are continuously aware of relevant laws and regulations and anticipate changes when designing and managing processes, data, systems, and infrastructure
Rationale	By having proactive insight into laws and regulations, organizations can adjust their systems and processes in a timely manner, reducing the risk of non-compliance, fines, or operational delays.
Implication	1. Establish processes to monitor new and changing laws and regulations 2. Conduct an impact analysis for new and changing laws and regulations
Domain	Business
Relation to regulation	-
Source	Interviews

Table 4.2: Good Practice Example

Name	Monitor laws and regulations
Relation to Principle	Proactive compliance
Description	Establish a process to continuously track new and amended laws and regulations through official sources, industry associations, and government updates. Document relevant changes and communicate them to the relevant teams
Impact	Ensures the organization stays informed in a timely manner, preventing non-compliance and fines
Source	Interview fragment

including management, policymakers, and IT professionals. While the principles provide high-level direction suitable for decision-makers, the good practices offer actionable guidance for those involved in implementation and operationalization.

4.3 Viewpoints and Views

The reference content consists of two elements, viewpoints and their corresponding views. In the context of enterprise architecture, a view can be defined as a representation of a system from the perspective of a specific set of concerns [45]. Viewpoints define these perspectives by specifying the concerns addressed, the intended stakeholders, and the conventions used to construct the view [45].

Viewpoints are necessary to provide structure and consistency in the way architectural views are created and interpreted. They specify how a view should be constructed, which information should be included, and which modeling techniques are applied. Most importantly, viewpoints make explicit the underlying concerns that justify these choices. An overview of the viewpoint structure used in this study is provided in Table 4.3.

By defining viewpoints, architectural complexity can be managed more effectively. Instead of presenting a single comprehensive model, the architecture is decomposed into views that focus on concerns relevant to specific stakeholder groups. Within the reference architecture, viewpoints and views serve as instruments to analyze, communicate, and apply the architectural principles and good practices in a structured manner. They translate abstract guidance into concrete representations that can be used during design, evaluation, and governance activities.

Table 4.3: Viewpoint Description

Field	**Description**
Viewpoint Name	Name of the viewpoint.
Stakeholders	The people, organizations, or roles with an interest in this viewpoint.
Concerns	The main questions or issues the viewpoint addresses.
Purpose	Why the viewpoint exists - its goal in supporting decision-making, design, or communication.
Scope	The parts of the architecture that are covered (layers, domains, systems).
Representation	The modeling language or notation used to represent the viewpoint.
Views	Individual visualizations or diagrams that show aspects of the architecture.
Elements	Overview of the architectural elements used in the views.

4.3.1 Design Decisions

For the reference architecture, a set of four viewpoints was defined, covering the most relevant architectural concerns within the fisheries sector across business and process-oriented, information-oriented, and technology-oriented perspectives. The set was deliberately kept limited to ensure usability and clarity while still providing sufficient coverage of the sector's key concerns, as seen in Table 4.4. Emphasis was placed on the business and application layers, as these are most directly affected by regulatory obligations, while the motivation layer captures underlying drivers and goals. The technology layer was included only to a limited extent, since detailed technical design considerations are beyond the scope of this study. ArchiMate was selected as the modelling notation because it can coherently represent multiple architectural layers, supports the explicit use of viewpoints and views, and aligns with widely adopted enterprise architecture frameworks.

The design of the viewpoints was informed by multiple sources. Contextual knowledge from exploratory interviews provided an understanding of the fisheries sector, while thematic analysis of in-depth interviews identified recurring challenges and gaps. Stakeholder interests and concerns from the stakeholder analysis clarified which issues each viewpoint should address, guiding the development of the corresponding views. Established EA frameworks from the document analysis, such as TOGAF, offered templates and structures for organizing and presenting viewpoints consistently. Feedback from evaluation interviews was incorporated to refine the viewpoints and ensure they accurately represented stakeholder perspectives and sector-specific concerns.

All sources were combined to form the final viewpoints. The process began with exploratory interviews and EA literature for context, followed by integration of themes from in-depth interviews and stakeholder concerns, resulting in four distinct viewpoints. These were then refined and validated using feedback from evaluation interviews, producing a coherent set of viewpoints and associated views that address key challenges in the sector.

4.3.2 Product Description

Users of the reference architecture receive a structured set of viewpoints and their associated views. Each viewpoint defines a specific perspective on the architecture by identifying relevant stakeholder concerns and specifying how these concerns are addressed. The corresponding views provide concrete visual representations of the architectural elements related to these concerns. An overview of the viewpoints, their scope, and the included views is shown in Table 4.4.

The viewpoints are modelled using the layers of ArchiMate. The business layer is primarily used to represent key actors, processes, and related information objects. The application layer complements this by modelling application components and services that support business activities. Limited use of the technology layer is made, as detailed technical infrastructure design falls outside the scope of this study. In addition, the motivation layer is incorporated to represent regulatory requirements, and constraints

Table 4.4: Viewpoint Overview

Viewpoint	**About**	**Views**
Compliance & Sector Communication	How regulations are developed, communicated, and implemented across organizations in the sector.	1. Regulation Development Workflow View 2. Regulation Implementation Workflow View 3. Regulatory Information Objects View
Compliance Process	The key activities, information objects, and systems required to achieve traceability and regulatory compliance.	1. Compliance Workflow View 2. Information Flow View 3. Systems & Integration View
System Landscape & Integration	An overview of the systems present in the fisheries sector, their services, and the interactions between actors.	1. Application Component, Application Service, Equipment, Node, Facility, Technology Service 2. Business Actor, Application Component, Application Service
Information Model	The structure and relationships of key information objects in the fisheries sector.	1. Core Information View 2. Information Object Hierarchy View 3. Information Standards & Structures View

that influence architectural design decisions.

The viewpoints do not cover the entire Dutch fisheries sector, but rather focus on the specific domain boundaries defined within the scope of this research.

The viewpoints and views can be applied in multiple practical contexts. During design activities, they support the development of new or adapted processes, particularly those influenced by regulatory requirements. They can also guide decisions on system integration and information traceability. In addition, they serve as communication instruments to align stakeholders on how processes, systems, and responsibilities are structured. Finally, they can be used for evaluation purposes, allowing organizations to compare their existing architecture against the reference architecture.

Each viewpoint captures a set of stakeholder concerns that are relevant for a specific perspective on the architecture. The corresponding views are derived directly from these concerns: for each concern identified in a viewpoint, one or more views are created to visualize and address that concern. This ensures that every concern has a concrete representation in the reference architecture, allowing users to understand, analyze, and make decisions based on the architectural elements that are relevant to each concern.

The process of deriving views from viewpoints followed these steps:

1. Identify concerns in each viewpoint based on interviews, stakeholder analysis, and sector-specific requirements.
2. Determine which architectural elements are relevant to each concern.
3. Design views that clearly represent these elements and their relationships, using ArchiMate notation to maintain consistency across the architecture.
4. Validate each view with stakeholders and refine them based on feedback, ensuring the concerns are adequately addressed and represented.

Table 4.4 shows an overview of the viewpoints, the concerns they capture, and the views that are associated with them. Complete viewpoints and their concerns are included in Appendix H. For example, the *Compliance Process* viewpoint captures concerns about traceability and regulatory compliance; the associated *Compliance Workflow View*, *Information Flow View*, and *Systems & Integration View* provide concrete visualizations of how processes, information objects, and systems interact to address these concerns.

By explicitly linking concerns to views, the reference architecture operationalizes the abstract guidance provided by the viewpoints. Users can follow the mapping from concerns to views to ensure that design, evaluation, and governance activities consistently address stakeholder priorities and sector-specific challenges.

Each viewpoint follows a standardized structure consisting of elements which are covered in Table 4.3. Views are developed using ArchiMate notation and are constructed in accordance with the specifications defined in their respective viewpoints. This structured approach aligns with established enterprise architecture practices and ensures consistency and clarity across the reference architecture.

Each viewpoint is associated with specific stakeholder groups whose concerns it addresses. These range from every type of role across the fisheries sector, including operational and supporting roles. Although viewpoints are scoped based on particular stakeholder concerns, their use is not restricted to those stakeholders; they may be applied more broadly within organizations depending on context and need.

In total four viewpoints were developed, resulting in eleven associated views. Detailed descriptions of the viewpoints are included in Appendix H, the corresponding views including descriptions are provided in Appendix I. The relations between the viewpoint's concerns and the views that address those are extensively described in these appendices as well.

4.4 Terminology

In this document, a set of key terms, their definitions, and possible abbreviations has been recorded in both Dutch and English. The terminology is not exhaustive; it contains a selective set of terms relevant to the fisheries sector, enterprise architecture, and the reference architecture.

The purpose of this terminology is to provide stakeholders with a reference document to support consistent understanding and communication when reading or discussing the reference architecture.

The terms were gathered from multiple sources, including mentions during interviews and existing enterprise architecture literature and frameworks, and were later supplemented with additional terms based on suggestions from the evaluation interviews.

An overview of the terminology is shown in Appendix J.

Chapter 5

Evaluation

The evaluation of the artifact was conducted through a series of evaluation sessions aimed at assessing its relevance, completeness, and practical usability within the fisheries sector. Two types of evaluation were performed. First, an expert evaluation was conducted throughout the iterative development of the artifact, where feedback was directly incorporated into the design. Second, an industry evaluation was conducted using a pre-final version of the artifact to assess its perceived value and applicability for the sector as a whole.

This chapter discusses the setup of the evaluation sessions and presents the results of both the expert and industry evaluations.

5.1 Expert Evaluation

The purpose of the expert evaluation was to assess interim versions of the artifact with domain experts. This formative evaluation provided feedback that was incorporated iteratively to improve the reference architecture. Experts from various roles within the fisheries sector participated, providing insights into the artifact's relevance, clarity, and practical applicability. In the following sections, we describe the evaluation design in more detail and present the quantitative and qualitative results obtained from the expert evaluation sessions.

5.1.1 Evaluation Design

We used an expert-based evaluation approach to evaluate the artifact. This has a formative nature, where ongoing feedback and evaluation was used to shape, refine and improve the artifact throughout the development. A group of 11 experts were identified through the stakeholder analysis as seen in Table 3.4. Experts were chosen based on their experience and relevance to different parts of the sector, ensuring diverse perspectives on the artifact's applicability and usefulness.

Each evaluation session began with a brief presentation to provide context about the research and the study's objectives. This was followed by a demonstration of the artifact, highlighting architecture principles & good practices, and viewpoints & views. After the demonstration, participants completed a questionnaire designed to gather quantitative and qualitative feedback on the artifact. The questionnaire was inspired by the Technology Acceptance Model (TAM) to structure evaluation constructs such as relevance, clarity, completeness, and practical applicability. The complete expert evaluation questionnaire is included in Appendix K. The first sessions showed a well thought-out example of architecture principle & good practice and viewpoint & view. Throughout the sessions, this was further developed and expanded with more elements to sketch a more complete picture of the reference architecture. Over successive validation sessions, new and revised content was discussed, but the number of new suggestions gradually decreased. This indicates that the content of the reference architecture reached a level of saturation, where most elements had been validated and few additional notes remained. This iterative process strengthened the content validity of the artifact.

5.1.2 Results

Table 5.1 presents the average scores per evaluation construct. Overall, the reference architecture was positively evaluated, resulting in an overall mean score of 4.07 out of 5. The results are discussed below per construct, followed by an overview of the qualitative themes identified from the open-ended responses. Quantitative and qualitative results per construct per participant is available in Appendix L.

Table 5.1: Average Evaluation Interview Scores per Construct

Construct	**Average Score (1-5)**
Problem Recognition	3.97
Relevance	4.21
Clarity & Understandability	4.45
Completeness	3.91
Practical Applicability	3.81
Final Questions	4.05
Overall Score	4.07

Quantitative Results

The construct *Problem Recognition* received a relatively high average score (3.97). Most participants indicated that they recognized the problem presented during the evaluation sessions and considered it relevant within their professional context. The necessity of addressing the problem at sector level was broadly acknowledged. The construct *Relevance* obtained a strong average score (4.21), indicating that participants perceived the reference architecture as addressing the identified problem effectively. The demonstrated components of the architecture were regarded as relevant across different roles and subdomains within the fisheries sector. *Clarity and Understandability* achieved the highest average score (4.45) among all constructs. Participants consistently indicated that the architecture was clearly explained and that the visualizations and models were understandable. The level of abstraction was perceived as appropriate, providing sufficient detail without becoming overly technical.

The construct *Completeness* received a positive but slightly lower average score (3.91). While participants generally considered the reference architecture to form a coherent and well-developed whole, several respondents identified potential additions or refinements. This indicates that the architecture was perceived as largely comprehensive, though still open to further elaboration. *Practical Applicability* resulted in a moderate yet positive average score (3.81) and showed greater variation among respondents. Some participants clearly recognized the potential for implementation within their organization, while others expressed uncertainty regarding feasibility or alignment with existing structures. This suggests that applicability may depend on organizational context and maturity.

The *Final Questions* yielded a positive overall assessment (4.05). Participants expressed a favorable general judgment of the reference architecture and indicated a high likelihood of recommending it within the sector.

Qualitative Results

The qualitative responses were analyzed thematically. Four main themes emerged from the open-ended feedback: perceived sector value, strength of structure and visualization, suggestions for refinement, and implementation challenges.

- **Perceived Sector Value**; participants described the reference architecture as a "blueprint for all parties in the sector," emphasizing its potential to establish a more uniform and structured approach. Several respondents highlighted that the architecture provides insight into the complexity of the fisheries sector, thereby fostering greater understanding across organizations and roles.
- **Strength of Structure and Visualization**; the graphical representations and structural clarity of the artifact were frequently mentioned as key strengths. Respondents appreciated the visualizations for making workflows, responsibilities, and interdependencies explicit. The architecture was perceived as providing an accessible overview of complex processes.

- **Suggestions for Refinement**; despite the overall positive assessment, participants provided constructive suggestions for improvement. These included linking architectural elements more explicitly to regulatory frameworks, adding or clarifying specific actors (such as regulatory bodies or internal departments), and further specifying certain components. These suggestions primarily concerned elaboration rather than fundamental changes.
- **Implementation Challenges**; several respondents addressed potential challenges related to implementation. These included the conservative culture within parts of the fisheries sector and the perception that practical experience alone may suffice without formalized structures. Additionally, participants emphasized the importance of clearly assigning responsibilities across actors to ensure effective adoption.

Although the overall tone of the feedback was positive, participants also provided several concrete suggestions for refinement and expressed contextual concerns regarding implementation.

5.2 Industry Evaluation

In contrast to the expert evaluation, the industry evaluation focused on assessing the relevance and value of the complete reference architecture at sector level, rather than on detailed design decisions. The evaluation aimed to validate whether the artifact, in its pre-finalized form, provides meaningful value for the fisheries sector as a whole. Participants were limited to trade associations involved in the study. While the setup of the sessions was similar to the expert evaluation, the emphasis shifted from iterative refinement to validation of the artifact.

5.2.1 Evaluation Design

For the industry evaluation, representatives of trade associations within the fisheries sector were selected based on the stakeholder analysis. These organizations play a central role in representing sector-wide interests and coordinating between governmental bodies and private organizations. Their involvement ensured that the evaluation reflected a sector-level perspective on the relevance and applicability of the reference architecture. One evaluation session was conducted per trade association. Each session was guided by a presentation that described the context and objectives of the study, followed by a detailed discussion of the reference architecture and its components. Compared to the expert evaluation, these sessions placed greater emphasis on the artifact in its entirety and its value for the sector, rather than on individual design choices or interim versions. The complete industry evaluation questionnaire is included in Appendix M.

The scope of the industry evaluation covered the complete reference architecture. The artifact as a whole was assessed in terms of its relevance in addressing challenges within the fisheries sector and the value it provides at sector level. Architecture principles and good practices were evaluated on their relevance and practical usability.. The viewpoints and views were assessed based on their ability to structure and represent different parts of the sector in a coherent manner. In addition, the terminology was evaluated on the clarity and adequacy of its explanations. The results of the industry evaluation were primarily used to validate the overall value and sector relevance of the reference architecture. In contrast to the expert evaluation, the feedback resulted in limited refinement of the artifact and mainly served as confirmation of its applicability and coherence at sector level.

5.2.2 Results

The results of the industry evaluation are presented below. Two trade associations participated, providing quantitative and qualitative input on the reference architecture. The evaluation focused on the relevance, clarity, completeness, and applicability of the artifact at the sector level. Quantitative and qualitative results per construct per participant is available in Appendix N.

Quantitative Results

Table 5.2 shows the average scores provided by the two trade associations across the six constructs. Overall, the reference architecture received positive evaluations, with all constructs scoring above 4 on a 5-point scale. The construct *Sector Relevance* received a strong average score (4.17), indicating that participants generally agreed that the reference architecture addresses the main challenges in traceability and

Table 5.2: Average Industry Evaluation Scores per Construct

Construct	**Average Score (1-5)**
Sector Relevance	4.17
Architecture Principles & Good Practices	4.33
Viewpoints & Views	4.17
Coherence & Completeness	4.25
Clarity of Terminology	4.25
Overall Assessment	4.50
Overall Score	**4.28**

compliance within the sector and provides added value over existing practices. The construct *Architecture Principles & Good Practices* achieved a high average score (4.33). Participants considered the principles clear and the good practices relevant and useful for organizations in the sector. The combination of explanatory documentation and practical overviews was perceived as supportive for implementation.

Viewpoints & Views received a positive average score (4.17). Participants found the viewpoints and views understandable and useful for communicating processes, responsibilities, and system interactions across the sector. The Compliance & Sector Communication viewpoint was highlighted as particularly valuable. *Coherence & Completeness* was rated positively (4.25), with participants indicating that the components of the architecture formed a coherent whole. Minor suggestions for additions were noted, but overall the architecture was seen as comprehensive. *Clarity of Terminology* scored 4.25 on average. Participants generally agreed that the glossary provides a clear and relevant understanding of key concepts, with only minor additions suggested for completeness. The *Overall Assessment* yielded a high average score (4.50). Participants expressed a positive general judgment of the reference architecture and indicated a strong likelihood of recommending it to other organizations within the sector.

Qualitative Results

The qualitative feedback from the trade associations complements the quantitative scores, providing insights into the perceived value and applicability of the reference architecture. Participants emphasized that the architecture provides a clear overview of the sector, helping stakeholders understand responsibilities, workflows, and the interrelation between different actors.

The Compliance & Sector Communication viewpoint was highlighted as particularly valuable, as it helps manage risks related to regulatory changes and ensures a uniform approach across the sector. Participants appreciated that the artifact acts as a blueprint for sector-wide alignment, which can facilitate collaboration and decision-making among organizations.

Some suggestions for refinement were also noted, such as minor additions to the terminology. Overall, the feedback indicates that the reference architecture is both relevant and actionable for the sector, while providing opportunities for further improvements.

Overall, the evaluation shows that the reference architecture is positively received by both experts and industry stakeholders. Expert sessions with 11 participants resulted in an overall score of 4.07 out of 5, with particularly high ratings for clarity and relevance and repeated appreciation for the architecture as a sector-wide “blueprint.” The industry evaluation with trade associations confirmed these findings at sector level, with an overall score of 4.28 out of 5 and strong scores on sector relevance, coherence, and clarity of terminology. Together, these results indicate that the artifact is regarded as relevant, coherent, and practically usable for the fisheries sector, while offering concrete starting points for further refinement and implementation.

Chapter 6

Discussion

In this chapter, we take a step back to reflect on the main findings of the study. It begins by summarizing how the developed reference architecture supports traceability, alignment, and coordination in the Dutch fisheries sector, and how these results relate to the theoretical expectations of enterprise and reference architectures. The chapter then elaborates on the key insights that emerged from the research, outlines the practical and theoretical implications, and concludes with a discussion of methodological, contextual, and artifact-related limitations that should be taken into account when interpreting the results and their applicability.

6.1 Summary

Digital traceability of fish products has become mandatory, yet information fragmentation and limited architectural maturity in the Dutch fisheries sector have made compliance challenging. This research aimed to develop and evaluate a reference architecture (RA) for the sector to support alignment, traceability, and coordination.

The developed RA is based on established EA and RA frameworks and stakeholder insights from interviews. Evaluation sessions with industry experts and trade associations indicated that the RA provides practical guidance consistent with theoretical expectations, supporting decision-making, standardization, and interoperability.

The RA delivers value through sector-specific application, integrating processes, information, and technology into a coherent, governable structure. Traceability is revealed to be an architectural challenge rather than solely a technological issue. Furthermore, the RA functions not only as a design tool but also as a communication and coordination instrument across organizations. Industry feedback suggests potential for sector-wide adoption and long-term utility.

The findings confirm the theoretical benefits of EA and RA. The low architectural maturity of the sector offers opportunities for institutionalization of the RA, though the perceived value may be influenced by this context. Future adoption and impact will depend on organizational willingness and flexibility in application.

6.2 Interpretations

6.2.1 Expectations vs Results

In Chapter 2, we discussed the theoretical benefits of enterprise and reference architectures, including structured guidance that supports organizational alignment, decision-making, standardization, interoperability, and integration of processes, systems, and data - benefits that are relevant for enhancing traceability in the fisheries sector. Based on this literature, we expected that implementing a RA in the Dutch fisheries sector would yield similar advantages.

According to the results in Chapter 5, our findings confirm these theoretical expectations. Expert and industry evaluation participants reported that the RA provides a structured overview of processes, information, technology and relevant regulation, supports decision-making and offers reusable standards that facilitate interoperability.

These observations demonstrate that the RA functions as anticipated in the literature while providing practical guidance tailored to the Dutch fisheries sector. This suggests that the benefits often described in EA literature can also occur in sectors with relatively low architectural maturity, where structured guidance and shared models are mostly absent. However, these benefits are not guaranteed; they depend on organizational readiness and the ability to contextualize architectural guidance.

6.2.2 Explanation of Results

The observed results can be explained by a combination of stakeholder perspectives, artifact design, and sector context. First, the evaluation sessions involved mainly internal stakeholders from the host organization, with limited participation from external stakeholders such as trade associations. Internal stakeholders, who operate in day-to-day business, focused on the practical usability of the RA within their work. External stakeholders emphasized generalizability, assessing whether the RA could be applied across other organizations in the sector.

Second, the design of the reference architecture was based on established enterprise and reference architecture principles and incorporated data and elements gathered from interviews. This structured approach allowed stakeholders to gain insights relevant to their roles while simultaneously realizing the theoretical benefits of EA and RA. Furthermore, the RA explicitly emphasized traceability and integration of information and technology, which stakeholders recognized as valuable for regulatory compliance.

Finally, the Dutch fisheries sector has limited architectural maturity, and no sector-wide reference architecture currently exists. As a result, organizations were able to adopt the developed RA easily, since they had no alternative frameworks in place. This likely explains why stakeholders rated the artifact highly in terms of relevance, completeness, and practical applicability, as it provided a clear and structured solution where none existed before. This context also indicates that other sectors with fragmented information landscapes may benefit significantly from shared architectural guidance, as such structures provide a foundation for coordination that individual organizations may struggle to develop independently. This low architectural maturity offers opportunities, such as relatively easy adoption, but also poses challenges, including the need for extensive guidance during implementation.

6.2.3 Insights from Research

Besides confirming theoretical expectations, this study provides several additional insights.

The value of a reference architecture lies not only in its structure, but in its translation to a sector-specific context. The findings demonstrate that a reference architecture tailored to the Dutch fisheries sector provides tangible value to actors across the supply chain, including operational stakeholders and trade associations. While enterprise and reference architectures are theoretically positioned as valuable instruments, this study shows that their practical viability depends on contextualization. The perceived value came not only from the architectural structure itself, but from its alignment with sector-specific processes, regulatory requirements, and information flows.

Traceability is primarily an architectural challenge rather than solely a technological implementation issue. In the literature, traceability initiatives are often approached from a technological perspective. However, the findings indicate that effective traceability requires architectural coherence across business processes, information structures, technological components, and regulatory frameworks. Without such alignment, traceability solutions risk remaining fragmented and disconnected. This suggests that sustainable traceability in the fisheries sector should be addressed through architectural governance rather than isolated IT solutions.

Without architectural governance, organizations may continue implementing isolated technological solutions that do not align with sector-wide processes and information structures. As a result, traceability systems risk remaining fragmented, limiting interoperability and making regulatory compliance more difficult across the supply chain. This may partly explain why traceability initiatives in practice often struggle to achieve full supply-chain transparency. When solutions are implemented independently by individual organizations without architectural alignment, information fragmentation across systems and actors persists.

The reference architecture functions not only as a design instrument, but also as a communicative and coordinating mechanism. The study further reveals that the reference architecture supports communication between stakeholders with different roles and levels of expertise. By providing a shared representation of processes, responsibilities, and information exchanges, the artifact contributes to a common language within and across organizations. In this way, the reference architecture enhances coordination and mutual understanding, extending its value beyond purely technical design considerations.

Potential for Architecture Acceptance and Institutionalization. The findings also suggest that the RA could contribute to architecture adoption and eventual institutionalization within the Dutch fisheries sector. By providing a common language, reusable models, and a governance structure, the RA creates conditions for alignment across organizations. If widely adopted by multiple organizations, it could become a recognized standard for the sector, facilitating long-term coordination and standardization. In this sense, the reference architecture could act as a governance instrument for the sector. By providing shared principles, models, and viewpoints, it enables stakeholders to coordinate architectural decisions and align their systems and processes with common sector objectives. However, the degree of institutionalization will depend on the willingness of organizations to adopt the RA and on maintaining sufficient flexibility to avoid inhibiting innovation. Sectors with similar regulatory pressures and fragmented information landscapes may similarly benefit from contextually tailored reference architectures, suggesting that the approach is not limited to fisheries alone.

6.3 Implications

The findings of this study have several implications for both practice and theory. Here, we discuss the practical implications for the Dutch fisheries sector and the theoretical contributions to the literature.

6.3.1 Practical Implications

Organizations in the Dutch fisheries sector can leverage the reference architecture as a foundational blueprint for developing their own architectural structures. By adopting and adapting the provided principles, viewpoints, and views, organizations can respond more effectively to regulatory requirements and evolving operational challenges.

Trade associations can further expand on the reference architecture by formalizing architecture principles and best practices, and by sharing guidance and reference materials with their members. This promotes greater standardization across the sector, enabling interoperability, and coordinated responses to regulatory changes.

Furthermore, the reference architecture serves as a communication and coordination instrument, facilitating shared understanding among stakeholders across different roles and levels of expertise. This enhances collaboration and alignment within and between organizations in the sector.

Enterprise and reference architectures should not be regarded as one-time design efforts but as ongoing organizational capabilities. If the Dutch fisheries sector intends to realize the benefits identified in this study, organizations and trade associations will need to allocate dedicated resources and expertise to architecture governance. Without sustained attention to maintaining and evolving architectural principles, models, and standards, the long-term value of the reference architecture is likely to remain limited. A practical way to support this sustained architectural capability would be the creation of a sector-level Centre of Excellence. Such an entity could take responsibility for maintaining and evolving the reference architecture, supporting organizations in its implementation, and coordinating architectural knowledge and best practices across the sector.

6.3.2 Theoretical Implications

This study contributes to the literature by providing a sector-specific application of a reference architecture, which has not been previously documented for the Dutch fisheries sector. It confirms that the theoretical advantages of enterprise and reference architectures – such as alignment, decision support, standardization, and interoperability – can be realized in practice, even in a sector with relatively low architectural maturity.

Additionally, the findings highlight the importance of contextual adaptation: the practical value of a reference architecture depends on its translation to sector-specific processes, regulatory frameworks, and information flows. This insight adds nuance to the existing literature on EA and RA adoption, suggesting that perceived value may be amplified in contexts lacking prior architectural structures.

Beyond the Dutch fisheries sector, the approach and findings of this study are relevant for other sectors facing similar regulatory and operational challenges. Organizations in such contexts could achieve comparable benefits by applying reference architecture principles, demonstrating that the design, evaluation, and implementation approach used here can be transferred and adapted to other domains. This emphasizes the broader applicability and theoretical significance of EA and RA principles beyond the immediate case study, contributing to understanding how reference architectures can support alignment, governance, and coordination across diverse organizational and sectoral contexts.

6.4 Limitations

While the study shows promising results, there are several limitations that should be considered. These are categorized in three areas:

Methodological Limitations

- The data collection for the interviews involved a limited number of respondents, mainly from the pelagic fleet. While this allowed for an in-depth understanding of that specific segment, it limits the extent to which the findings can be generalized to the broader fisheries sector.
- Some stakeholder concerns may not have been fully captured in the viewpoints due to potential interpretation bias by the researcher, which could mean that certain aspects were not addressed in the views.

Contextual Limitations

- The study focuses on a sector-specific context, limited to pelagic fishing and processing. Other regions, vessel types, or fishing practices were not included.
- The relatively low architectural maturity of the sector may have amplified the perceived value of the reference architecture. As stakeholders had no prior sector-wide architectural frameworks, the high scores for relevance, completeness, and practical applicability may partly reflect this context.
- Attempts to validate the reference architecture with external fisheries operating pelagic vessels were unsuccessful, limiting external validation of its generalizability.

Artifact-related Limitations

- The reference architecture is generic and not tailored to any single organization. While this ensures sector-wide applicability, it may not fully include all elements present in individual organizations or cover all specific operational nuances.

Chapter 7

Conclusions

7.1 Answers to the research questions

SRQ.1 What are the current and future regulatory requirements in the fisheries sector, and how do these requirements affect business processes, applications, and IT infrastructure?

The document analysis shows that the Dutch fisheries sector faces an increasingly strict and expanding regulatory landscape, primarily driven by EU Regulation 2023/2842, which mandates digital traceability across the entire supply chain. This regulation requires actors to register and exchange detailed information such as vessel data, FAO fishing areas, catch dates, batch identifiers, and processing information.

Interview results confirm that these regulatory requirements have significant impact on business processes. Companies must adjust workflows to ensure timely and complete data recording and manage increased administrative workloads. Participants indicated that regulatory updates often occur close to implementation deadlines, leaving insufficient time to prepare and increasing operational pressure.

For applications and IT infrastructure, the new requirements require the use of standardized systems such as Electronic Reporting Systems (ERS) and Vessel Monitoring Systems (VMS), as well as adaptations to existing enterprise systems to support data capture, integration, and reporting. Fragmented systems and a lack of common data models further complicate the fulfillment of traceability obligations. As a result, organizations experience challenges in interoperability, data consistency, and maintaining a reliable IT landscape that supports compliance.

Overall, current and future regulatory requirements impose significant changes across processes, information, and technology, requiring improved interoperability, standardized data exchange, and organizational readiness for continuous regulatory change.

SRQ.2 Which enterprise architecture principles and governance mechanisms are relevant to supporting regulatory compliance in fisheries companies?

The reference architecture developed in this study is grounded in principles identified from industry frameworks, such as TOGAF and NORA, and insights from interviews. Four enterprise architecture principles were developed, which are considered relevant for supporting regulatory compliance in the fisheries sector:

1. **Standardize where possible**; standardization supports interoperability and reduces ambiguity between organizations and systems
2. **Security by design**; security and privacy are considered from the start when designing processes, systems, and IT infrastructure
3. **Promote interoperability**; ensuring that systems and data structures can exchange information reliably is a prerequisite for sector-wide traceability
4. **Proactive compliance**; organizations must anticipate regulatory change and have mechanisms to assess, plan, and implement compliance requirements proactively

These principles are operationalized through good practices that guide organizations in implementing consistent processes, managing data securely, and integrating systems effectively. Together, they form a governance foundation that enables fisheries companies to align business and IT with regulatory obligations in a structured and repeatable way.

In conclusion, architecture principles – particularly standardization, security, interoperability, and proactive compliance – provide governance mechanisms that enable fisheries companies to manage regulatory complexity and support consistent implementation across organizations.

SRQ.3 Which layers, components, and guidelines should a reference architecture include to support fisheries companies in complying with regulatory requirements?

The study identifies that the reference architecture should primarily focus on the business, information, and application layers, as these layers are most directly impacted by regulatory obligations and traceability requirements. Key architectural components include:

- **Business layer**; actors, processes, and workflows involved in generating, validating, and exchanging traceability information
- **Information layer**; core information objects, standardized data elements (e.g., species, FAO zones, vessel IDs), and relationships between them
- **Application layer**; systems such as ERS, VMS, production systems, and internal data management platforms
- **Motivation layer**; regulatory drivers, constraints, and compliance requirements that shape architectural decisions

The reference architecture provides eleven views across four viewpoints – Compliance & Sector Communication, Compliance Process, System Landscape & Integration, and Information Model – each offering targeted guidance for structuring processes, data flows, and system interactions.

A reference architecture for the fisheries sector must include structured guidance on business processes, data standards, system interactions, and regulatory requirements to enable coherent, interoperable, and compliant operations.

SRQ.4 Is the reference architecture applicable across fisheries companies, and to what extent is it generalizable?

The evaluation results, based on both expert and industry feedback, show that the reference architecture is applicable across the Dutch fisheries sector. Experts from vessel operations, processing, sales & export, legal, and IT domains described the artifact as relevant, clear, and valuable for addressing traceability challenges. Trade associations indicated that the architecture provides sector-level value and can function as a blueprint for their members. This acceptance suggests strong potential for sector-wide adoption. Participants also noted that the architecture's abstraction level and use of principles rather than technical prescriptions make it adaptable to organizations with varying maturity levels.

In conclusion, the reference architecture is generalizable and suitable for sector-wide use, with the potential to become institutionalized as a standard for traceability and compliance in the Dutch fisheries sector.

How can a reference architecture support fisheries companies in identifying and aligning the business processes, applications, and IT infrastructure required for compliance with current and future regulatory requirements?

Based on the findings, it can be concluded that a reference architecture supports fisheries companies in several key ways:

- It provides a structured and coherent overview of sector processes, data flows, and system dependencies
- It aligns business processes, information, and applications with regulatory requirements, reducing ambiguity and fragmentation

- It offers architecture principles and good practices that guide organizations in making consistent design and implementation decisions
- It enhances interoperability by promoting standardized data elements and information structures
- It functions as a communication and coordination tool, enabling stakeholders across the supply chain to work from common definitions and shared insights
- It supports proactive compliance by clarifying regulatory drivers and the implications for processes, applications, and infrastructure

A reference architecture enables fisheries companies to structure their processes, systems, and information flows in a way that supports both current and future regulatory compliance. It improves alignment, enhances interoperability, increases transparency, and reduces the complexity associated with regulatory change.

7.2 Contributions

This study contributes the first sector-specific reference architecture for the Dutch fisheries sector, addressing a clear gap in both academic literature and industry practice. The architecture provides a unified conceptual framework that supports organizations in interpreting, structuring, and implementing regulatory traceability requirements. By offering standardized principles, good practices, viewpoints, and views, the reference architecture facilitates interoperability, enhances data consistency, and promotes coordinated action across the supply chain. Trade associations have expressed willingness to share the architecture with their members, indicating potential for sector-wide institutionalization. Beyond the fisheries domain, the methodological approach and the structure of the developed reference architecture offer a replicable model for other sectors facing similar challenges related to regulation-driven digital transformation, fragmented architectures, and interoperability constraints.

7.3 Future work

1. Future research could expand the current reference architecture to include other fisheries domains, such as demersal fisheries, aquaculture, or import/export networks, enabling broader sector-wide standardization.
2. Further studies should investigate implementation and adoption strategies for reference architectures within the Dutch fisheries sector, including governance models, maturity assessments, and change management approaches.
3. Additional validation across multiple independent fisheries organizations would strengthen generalizability and support cross-sector comparison, particularly as regulatory pressures continue to increase.

Bibliography

[1] Regulation (eu) 2023/2842. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R2842. Accessed: 2025-10-06.

[2] Nora (nederlandse overheid referentie architectuur) - digitale overheid. https://www.noraonline.nl/. Accessed: 2025-10-06.

[3] Agrimatie / Wageningen University & Research. Visserij in cijfers, 2024. https://agrimatie.nl/visserij/archief-visserij-in-cijfers-2024/, mei 2024. Gepubliceerd op 31 mei 2024; geraadpleegd op 5 december 2025.

[4] S.A. Bernard. *An Introduction to Enterprise Architecture: Third Edition*. AuthorHouse, Bloomington, IN, 2005.

[5] T Bhatt, C Cusack, B Dent, M Gooch, D Jones, R Newsome, J Stitzinger, G Sylvia, and J Zhang. Project to develop an interoperable seafood traceability technology architecture: Issues brief. *Comprehensive Reviews in Food Science and Food Safety*, 15(2):392–429, 2016. doi: 10.1111/1541-4337.12187.

[6] T Bhatt, M Gooch, B Dent, and G Sylvia. Implementing interoperability in the seafood industry: Learning from experiences in other sectors. *Journal of Food Science*, 82(S1), 2017. doi: 10.1111/1750-3841.13742.

[7] Wai Boh and Daniel Yellin. Using enterprise architecture standards in managing information technology. *J. of Management Information Systems*, 23:163–207, 01 2007. doi: 10.2753/MIS0742-1222230307.

[8] Xavier Brusset and Christoph Teller. Supply chain capabilities, risks, and resilience. *International journal of production economics*, 184:59–68, 2017.

[9] C Callinan, A Vega, T Clohessy, and G Heaslip. Blockchain adoption factors, enablers and barriers in fisheries supply chain. *The Journal of The British Blockchain Association*, 2022.

[10] Mehmet Oytun Cibaroğlu, Naciye Güliz Uğur, and Aykut Hamit Turan. Extending technology acceptance model (tam) with the theory of technology readiness. *International Journal of Economics and Administrative Studies*, 31:1–22, 2021. doi: 10.18092/ulikidince.700939. URL https://dergipark.org.tr/en/pub/ulikidince/article/700939. Geraadpleegd op 6 januari 2026.

[11] R. Cloutier and G. Müller. The concept of reference architectures. *Systems Engineering*, 13 (1):14–27, 2010. doi: 10.1002/sys.20129. URL https://wiki.lib.sun.ac.za/images/c/cb/TheConceptOfReferenceArchitectures.pdf.

[12] J Cromwell, C Turkson, M Dora, and FA Yamoah. Digital technologies for traceability and transparency in the global fish supply chains: A systematic review and future directions. *Marine Policy*, 178:106700, 2025. doi: 10.1016/j.marpol.2025.106700.

[13] Fred D. Davis. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3):319–340, 1989.

[14] Alyne Delaney, David G. Reid, Christopher Zimmermann, Marloes Kraan, Nathalie A. Steins, and Michel J. Kaiser. Socio-technical approaches are needed for innovation in fisheries. *Reviews in Fisheries Science & Aquaculture*, 31(2):161–179, 2023. doi: 10.1080/23308249.2022.2047886. URL https://www.tandfonline.com/doi/full/10.1080/23308249.2022.2047886. Geraadpleegd op 6 januari 2026.

[15] European Commission. The eu fish market (2023 edition), 2023. URL https://marketac.eu/wp-content/uploads/2023/11/EUMOFA-Presentation-The-EU-Fish-Market-2023.pdf. Geraadpleegd: 2025-10-17.

[16] European Commission, DG for Maritime Affairs and Fisheries. Inspections, monitoring and surveillance in fisheries. https://oceans-and-fisheries.ec.europa.eu/fisheries/rules/enforcing-rules/inspections-monitoring-and-surveillance_en, 2025. Accessed: 2025-12-24.

[17] European Parliament and Council of the European Union. Regulation (eu) no 1379/2013 of the european parliament and of the council of 11 december 2013 on the common organisation of the markets in fishery and aquaculture products. https://eur-lex.europa.eu/legal-content/NL/TXT/PDF/?uri=CELEX:32013R1379, 2013. geraadpleegd op 7 januari 2026.

[18] Europese Unie. Verordening (eu) nr. 1380/2013 van het europees parlement en de raad van 11 december 2013 inzake het gemeenschappelijk visserijbeleid, 2013. URL https://eur-lex.europa.eu/legal-content/NL/TXT/?uri=CELEX:32013R1380.

[19] FAO. Network of fisheries ontologies. https://aims.fao.org/network-fisheries-ontologies. Geraadpleegd op 2 december 2025.

[20] Devi Fitrianah, Nursidik H. Praptono, Remmy A.M. Zen, Achmad Nizar Hidayanto, and Aniati Murni Arymurthy. An integrated system architecture in managing fishery data in indonesia. In *2014 Fourth International Conference on Digital Information and Communication Technology and its Applications (DICTAP)*, pages 101–108, 2014. doi: 10.1109/DICTAP.2014.6821665.

[21] S Ge, R Yang, and S Olsson. Transparency within the seafood sector: Semantic interoperability between certifications and regulations connected to fishery products. 2023.

[22] GS1. *GS1 Global Traceability Standard*. GS1, 2017. URL https://www.gs1.org/sites/default/files/docs/traceability/GS1_Global_Traceability_Standard_i2.pdf. Geraadpleegd op 5 december 2025.

[23] K Haki and C Legner. The mechanics of enterprise architecture principles. *Journal of the Association for Information Systems*, 22(5):1334–1375, 2021. doi: 10.17705/1jais.00696.

[24] MJ Hardt, K Flett, and CJ Howell. Current barriers to large-scale interoperability of traceability technology in the seafood sector. *Journal of Food Science*, 82(S1), 2017. doi: 10.1111/1750-3841.13796.

[25] Svein Jentoft. Institutions in fisheries: what they are, what they do, and how they change. *Marine Policy*, 28(2):137–149, 2004. ISSN 0308-597X. doi: https://doi.org/10.1016/S0308-597X(03)00085-X. URL https://www.sciencedirect.com/science/article/pii/S0308597X0300085X.

[26] Kennisnet. Fora: Funderend onderwijs referentie architectuur. https://www.kennisnet.nl/diensten/fora-funderend-onderwijs-referentie-architectuur/. Geraadpleegd op 2 december 2025.

[27] Mohammad Ali Kohansal. *Navigating Enterprise Architecture (EA) Institutionalization: The Interplay of EA and Agile*. 2024.

[28] W Li, R Song, and K Yu. Consumer adoption of food blockchain traceability: Insights from integrating tam and tr models. *Frontiers in Sustainable Food Systems*, 9:1515188, 2025.

[29] C Liu, C Li, Y Ling, Y Ling, and Z Na. Research on seafood traceability system based on blockchain. In *Communications in computer and information science*, pages 183–193. 2025. doi: 10.1007/978-981-96-1614-5_12.

[30] ER Macusi, I Nallos, E Borazon, M Castro, and C Peralez. Fisheries traceability, drivers and barriers to its adoption: A review. *The Philippine Journal of Fisheries*, 31(1):39–60, 2024. doi: 10.31398/tpjf/31.1.2024-0025.

[31] Davit Marikyan and Savvas Papagiannidis. Technology acceptance model: A review. `https://open.ncl.ac.uk/theories/1/technology-acceptance-model/`, 2025. Geraadpleegd op 6 januari 2026; onderdeel van TheoryHub Book, Theory review gepubliceerd via Newcastle University.

[32] JB Matias. Understanding intention and behavior toward online purchase of agriculture and fisheries products using extended technology acceptance model. *International Journal of Enterprise Information Systems*, 17(4):118–137, 2021. doi: 10.4018/ijeis.2021100107.

[33] Ronald K. Mitchell, Bradley R. Agle, and Donna J. Wood. Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of Management Review*, 22(4):853–886, 1997. doi: 10.5465/amr.1997.9711022105.

[34] T Moe. Perspectives on traceability in food manufacture. *Trends in Food Science Technology*, 9(5):211–214, 1998. ISSN 0924-2244. doi: https://doi.org/10.1016/S0924-2244(98)00037-5. URL `https://www.sciencedirect.com/science/article/pii/S0924224498000375`.

[35] Pratyush Kumar Patro, Raja Jayaraman, Khaled Salah, and Ibrar Yaqoob. Blockchain-based traceability for the fishery supply chain. *IEEE Access*, 10, 07 2022. doi: 10.1109/ACCESS.2022.3196162.

[36] Ken Peffers, Tuure Tuunanen, Marcus A Rothenberger, and Samir Chatterjee. A design science research methodology for information systems research. *Journal of management information systems*, 24(3):45–77, 2007.

[37] GM Razak, LC Hendry, and M Stevenson. Supply chain traceability: a review of the benefits and its relationship with supply chain resilience. *Production Planning & Control*, 34(11):1114–1134, 2021. doi: 10.1080/09537287.2021.1983661.

[38] Rijksdienst voor Ondernemend Nederland (RVO). Visreis doorgeven vaartuigen kleiner dan 12 meter. `https://www.rvo.nl/onderwerpen/vangstregistratie/vaartuigen-12-meter-kleiner`. Laatst gecontroleerd op 29 oktober 2025; geraadpleegd op 5 december 2025.

[39] E Rogante, R van Wessel, and H de Vries. Factors that influence the dominance of an enterprise reference architecture: A comparative case study. *Journal of Standardisation*, 1, 2022. doi: 10.18757/jos.2022.6253.

[40] V Roy. Contrasting supply chain traceability and supply chain visibility: are they interchangeable? *The International Journal of Logistics Management*, 32(3):942–972, 2021. doi: 10.1108/ijlm-05-2020-0214.

[41] RVO. Visreis doorgeven vaartuigen van 12 meter of langer. `https://www.rvo.nl/onderwerpen/vangstregistratie/vaartuigen-12-meter-langer`. Laatst gecontroleerd op 29 oktober 2025; geraadpleegd op 5 december 2025.

[42] N Schäfer. Making transparency transparent: a systematic literature review to define and frame supply chain transparency in the context of sustainability. *Management Review Quarterly*, 73: 579–604, 2023. doi: 10.1007/s11301-021-00252-7.

[43] SURF. Hoger onderwijs referentie architectuur (hora). `https://www.surf.nl/themas/architectuur-standaarden/hoger-onderwijs-referentie-architectuur-hora`. Geraadpleegd op 2 december 2025.

[44] T. Tamm, P. B. Seddon, G. Shanks, and P. Reynolds. How does enterprise architecture add value to organisations? *European Journal of Information Systems*, 20(2):113–127, 2011. doi: 10.1057/ejis.2010.51.

[45] The Open Group. Developing architecture views – introduction. `https://www.opengroup.org/architecture/0210can/togaf8/doc-review/togaf8cr/c/p4/views/vus_intro.htm`, 1998–2002. Geraadpleegd op 26 januari 2026.

[46] The Open Group. Chapter 3 — definitions (togaf 8 “enterprise edition”). `https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap03.html`, 2002. Geraadpleegd op 2 januari 2026.

[47] United Nations Economic Commission for Europe. Un/flux – united nations fisheries language for universal exchange. `https://unece.org/trade/uncefact/unflux`, 2021. Accessed: 2025-12-24.

[48] HPM van Steenbergen and P Ravesteijn. Contribution of enterprise architecture in the. In *Enterprise Design, Operations, and Computing: 28th International Conference, EDOC 2024, Vienna, Austria, September 10–13, 2024, Revised Selected Papers*, volume 15409, page 140. Springer Nature, 2025.

[49] T Vehanen, M Piria, J Kubečka, C Skov, F Kelly, H Pokki, P Eskelinen, M Rahikainen, T Keskinen, J Artell, A Romakkaniemi, J Suić, Z Adámek, R Heimlich, P Chalupa, H Ženíšková, R Lyach, S Berg, K Birnie-Gauvin, and R ... Arlinghaus. *Data collection systems and methodologies for the inland fisheries of Europe*. FAO eBooks, 2020. doi: 10.4060/ca7993en.

[50] Visual Paradigm. The all-in-one togaf guide. `https://guides.visual-paradigm.com/the-all-in-one-togaf-guide/`, 2023. Geraadpleegd op 2 januari 2026.

[51] Zachman International / FEAC Institute. About the zachman framework. `https://zachman-feac.com/zachman/about-the-zachman-framework`, 2008. Geraadpleegd op 2 januari 2026.

Appendix A

Overview of Major EU Fisheries Legislation

Table A.1: Overview of Major EU Fisheries Legislation

Domain	**Regulation**	**Scope / Description**
Fisheries Policy (CFP)	1380/2013	Sustainability, management, MSY
Market Organization (GMO)	1379/2013	Market, Producer Organizations (POs), labeling
Control	1224/2009	Control chain, e-logbook, inspections
Control (update)	2023/2842	Modernized control system, digital traceability, e-logbook, recreational fisheries, stricter inspections
IUU Enforcement	1005/2008	Catch certificates, third-country compliance
Data Collection	2017/1004	Scientific and economic data
Technical Measures	2019/1241	Fishing gear, closed areas, mesh sizes, selectivity
Technical Measures (amendments)	2022/2023 (various delegated acts)	Gear adjustments, specific fishing grounds, technical updates
Access to Third Countries	2017/2403	EU fleet outside EU waters
Discard Ban Implementation	2015/812	Implementation of discard ban

Appendix B

Document Analysis Overview

Table B.1: Document Analysis Overview

Document Type	Title	Purpose	Source
Regulatory Documents	Regulation EU No 2023/2842	Provides regulatory framework for sustainable fishing	European Commission, 2023 [link]
Regulatory Documents	EU Control Regulation 1224/2009	EU Catch Documentation Scheme (CDS)	European Commission, 2009 [link]
Regulatory Documents	EU Traceability Regulation 1379/2013	EU Landing Declaration Rules	European Commission, 2013 [link]
Regulatory Documents	EU IUU Regulation 1005/2008	Establishes measures to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing	European Commission, 2008 [link]
Regulatory Documents	EU Hygiene & Food Fasety Regulations (852/2004, 853/2004, 2017/625)	Sets hygiene and food safety standards for food production and handling	European Commission, 2004 [link] European Commission, 2004 [link] European Commission, 2017 [link]
Enterprise and Reference Architecture Frameworks	TOGAF (The Open Group Architecture Framework)	Framework for enterprise architecture development	The Open Group [link]
Enterprise and Reference Architecture Frameworks	NORA (Nederlandse Overheid Referentie Architectuur)	Provides a reference framework for structuring processes, information objects, and IT systems in the public sector	Dutch Government [link]
Enterprise and Reference Architecture Frameworks	ArchiXL	Provides reference architecture examples and modelling techniques	ArchiXL Repository [link]
Enterprise and Reference Architecture Frameworks	European Interoperability Framework.	Provides guidelines for public sector interoperability	European Commission [link]

Continued on next page

Table B.1 – continued from previous page

Document Type	Document Title	Purpose	Source
Industry Standards	FAO Major Fishing Areas	Standardized geographic areas for global fisheries statistics and reporting	FAO [link]
Industry Standards	ISO 8601	International standard for date and time representations	ISO [link]
Industry Standards	FAO Species for Fishery Statistics Purposes (NFISS)	Standardized species list used statistical reporting and monitoring in fisheries	FAO [link]
Industry Standards	FAO – International Standard Statistical Classification of Fishing Gear	Standardized codes and definitions for fishing gear types to support reporting and comparability	FAO [link]
Industry Standards	ISO 3166	International standard for country codes	ISO [link]
Industry Standards	IMO Number	Unique identifier for ships, used in vessel tracking and traceability	IMO [link]
Industry Standards	UN/FLUX Vessel Domain	Defines a standardized data domain for identifying and describing vessels	UNECE [link]
Industry Standards	UN/FLUX Fishing Domain	Establishes a standardized data domain for recording fishing activities	UNECE [link]
Industry Standards	Global Dialogue on Seafood Traceability (GDST)	Provides global guidelines and best practices for seafood traceability, including standardized data elements	GDST [link]

Appendix C

In-depth Interview Questions

Thema’s en vragen uit interview Stuurman

1) Wettelijke eisen in de visserijsector

Wat merkt je aan boord van wet- en regelgeving?

- Zijn er verschillen tussen nationale en Europese eisen die verwarring veroorzaken?

2) Impact op business processen

Hoe leg je aan boord vangstdata vast en wat zijn daarin de grootste uitdagingen?

- Wie is verantwoordelijk voor het invoeren en controleren van de data?
- Waar gaat het meestal mis of loopt het traag?
- Heeft de dataregistratie invloed op de dagelijkse werkzaamheden of planning?

3) Impact op applicaties en systemen

Hoe registreer je data (bijv. elektronisch logboek) en hoe werkt dat in de praktijk?

- Werkt u met meerdere systemen (bijv. logboek, sensors, traceability-apps)?
- Hoe goed sluiten die systemen op elkaar aan?

4) Ervaringen en verwachtingen

Hoe ervaar je de administratieve last van traceability aan boord?

- Hoe is dit veranderd ten opzichte van een paar jaar geleden?
- Ervaart u vooral voordelen (bijv. transparantie) of nadelen (meer werk)?

Thema's en vragen uit interview Visverwerkings manager

1) Wettelijke eisen in de visserijsector

Wat voor impact heeft de traceability verordening op de dagelijkse productiewerkzaamheden?

- Zijn er extra stappen die nu gedaan worden die eerder niet nodig waren?
- In hoeverre is extra controle of verificatie nodig tijdens de productie?
- Zijn er bepaalde verplichtingen die lastig te combineren zijn met het tempo of volume van productie?

2) Impact op business processen

Welke informatie wordt gebruikt in de dagelijkse productiewerkzaamheden?

- Hoe wordt bij ontvangst gecontroleerd of alle verplichte traceability-informatie aanwezig is?
- Hoe wordt traceerbaarheid geborgd tijdens het verwerken, fileren, verpakken, etc.?
- Welke informatie (bijv. partijgegevens, FAO-zone, vangstmethode) is operationeel het meest kritisch?
- Zijn er momenten waarop de productie moet wachten vanwege ontbrekende data?

3) Impact op applicaties en systemen

Welke systemen worden gebruikt in de dagelijkse productiewerkzaamheden?

- Is er een onderscheid tussen IT en OT?
- Welke informatie genereren die machines?
- Hoe wordt informatie verzameld / uitgewisseld?

4) Impact op IT-infrastructuur

Welke uitdagingen ziet u in het opslaan en delen van traceabilitydata?

- Hoe wordt informatie gedeeld tussen productie, inkoop en logistiek?
- Zijn er koppelingen met leveranciers of klanten?

5) Ervaringen en verwachtingen

Hoe ervaart u de praktische uitvoerbaarheid van traceability in de praktijk?

- Wat is de ervaring of sentiment van de traceability wetgeving tot nu toe?
- Is het werk efficiënter, moeilijker of hetzelfde geworden door de nieuwe eisen?

Thema’s en vragen uit interview Sales manager

1) Wettelijke eisen in de visserijsector

Hoe beïnvloedt de verordening de relatie met klanten en exportvereisten?

- Heeft regelgeving invloed op de complexiteit van exportprocessen?
- Stellen (buitenlandse) klanten documentatie-eisen op?
- Verschillen die eisen per land of markt?
- Hoe ga je om met klanten die aanvullende eisen stellen bovenop de wetgeving?

2) Impact op business processen

Wordt traceabilityinformatie gebruikt in verkoop- of exportprocessen?

- Moeten verkoopmedewerkers specifieke data of documenten aanleveren aan klanten?
- Op welk moment in het verkoopproces wordt traceabilityinformatie toegevoegd of gecontroleerd?
- Hoe wordt geborgd dat de informatie klopt voordat deze naar de klant gaat?

3) Impact op applicaties en systemen

Welke systemen gebruikt u om traceabilitygegevens aan klanten te delen?

- Zijn er richtlijnen over welke informatie wel of niet gedeeld mag worden?
- Wordt gecontroleerd of gedeelde data actueel en juist is?
- Hoe wordt samengewerkt met IT of juridische afdelingen bij deling van data?

4) Ervaringen en verwachtingen

Hoe ervaart u de verwachtingen van klanten rond traceability en transparantie?

- Hoe belangrijk is transparantie voor klanten?
- Is er vraag vanuit klanten voor traceerbaarheidsinformatie of certificaten?

Thema's en vragen uit interview IT-manager

1) Wettelijke eisen in de visserijsector
    a. Overzicht maken van de verschillende implicaties van verordening EU 2023/2842
  - Elektronische vangstregistratie (M-Catch) en vessel monitoring systemen (VMS)
  - Uitbreiding van traceerbaarheid naar geïmporteerde visproducten
  - Uniformering van normen en standaarden

Statement: *Digitale traceerbaarheid is een vereiste per januari 2026*

Hoe heeft dat impact op jouw werkzaamheden op de volgende thema's?

2) Impact op business processen
    a. Welke handelingen moeten er anders of zijn nieuwe door de verordening?

3) Impact op applicaties en systemen
    a. Wat voor systemen gebruik je voor je processen? Welke handelingen/onderdelen zijn er specifiek om te voldoen aan de verordeningen?

4) Impact op IT-infrastructuur
    a. Wat voor (fysieke) apparatuur is nodig om te voldoen aan de verordening?

5) Ervaringen en verwachtingen
    a. Wat is het gevoel bij de wettelijke vereisten die gesteld zijn?
        i. Is het haalbaar?
        ii. Maakt het moeilijker / makkelijker?

Thema's en vragen uit interview Legal

1) Wettelijke eisen in de visserijsector

Hoe vertaalt de organisatie een (traceability-)verordening naar beleid en juridische verplichtingen?

- Is er intern beleid of documentatie opgesteld naar aanleiding van nieuwe regels?
- Hoe verloopt de communicatie tussen juridische afdeling en operationele afdelingen over naleving?

2) Impact op business processen

Hoe wordt compliance gecontroleerd in de bedrijfsprocessen?

- Op welke momenten in het proces wordt gecontroleerd of de regelgeving wordt nageleefd?
- Hoe wordt verantwoordelijkheid bepaald voor die controles, en hoe wordt dit vastgelegd?

3) Impact op IT-infrastructuur

Welke eisen of risico's zien jullie op het gebied van databeveiliging of juridische aansprakelijkheid?

- Hoe wordt dataverwerking met externe partijen juridisch geregeld?

4) Ervaringen en verwachtingen

Hoe ervaren jullie de duidelijkheid en uitvoerbaarheid van de traceability-regelgeving juridisch gezien?

- Zijn de juridische verplichtingen volgens jullie duidelijk genoeg geformuleerd door de EU?
- Hoe ervaren jullie de samenwerking met andere partijen (zoals NVWA of klanten) rond naleving?
- Verwachten jullie dat de regelgeving in de toekomst verder aangescherpt of verduidelijkt wordt?

Appendix D

In-depth Interview Codes, Themes and Clusters

Table D.1: Overview of Interview Codes and Themes

Participant	Code	Theme
IT-Manager	slechte interne communicatie	Communicatie & Informatievoorziening
IT-Manager	tijdsnood door informatiegebrek	Communicatie & Informatievoorziening
IT-Manager	Onvoldoende toelichting communicatie	Governance & Compliance-processen
IT-Manager	geen richtlijnen behandeling wetgeving	Governance & Compliance-processen
IT-Manager	voorstel aanpak interne informatievoorziening	Huidige IT-capaciteiten & Sterktes
IT-Manager	interne traceability in orde	Fragmentatie & Data-inconsistentie
IT-Manager	externe traceability matig	Fragmentatie & Data-inconsistentie
IT-Manager	data fragmentatie	IT-Awareness & Digitale Maturity
IT-Manager	onbewustzijn IT-aspect	Fragmentatie & Organisatorische Silovorming
IT-Manager	gebrek aan protocollen	Huidige IT-capaciteiten & Sterktes
IT-Manager	volwassenheid IT	Datakwaliteit & Procesrisico's
IT-Manager	onvoldoende data controle checks	Digitalisering & Ketensamenwerking
IT-Manager	kans voor datauitwisseling	Organisatorische Structuur & Rollen
IT-Manager	verbeterpunten structuur	Integratie van Systemen (IT/OT convergence)
IT-Manager	koppeling IT en OT	Operationele Digitalisering
IT-Manager	OT verbeteringen nodig	Fragmentatie & Technische Silovorming
IT-Manager	scheiding IT en OT	Operationele Digitalisering / Automatisering

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Table D.1 – continued from previous page

Deelnemer	Code	Thema
IT-Manager	Productieproces op schip	Datakwaliteit & Procesrisico's
IT-Manager	foutgevoeligheid handwerk	Datakwaliteit & Procesrisico's
IT-Manager	gevolgen fouten handwerk	Data Governance & Security
IT-Manager	onduidelijkheid informatieuitwisseling met organisaties	Data Governance & Security
IT-Manager	mensenlijk aspect	Organisatiedruk & Capaciteit
Sales Manager	Afhankelijkheid per regio	Regionale verschillen in traceability-eisen
Sales Manager	Bewijsstuk	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Toename in vraag bewijsstukken	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Administratieve lasten	Administratieve impact
Sales Manager	Uitzondering van oplevering bewijsstukken	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Oplevering bewijsstukken	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Bereidbaarheid voor oplevering bewijsstukken	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Afhankelijkheid per regio	Afhankelijkheid per regio
Sales Manager	Systeem koppeling	Gebruik en rol van systemen
Sales Manager	Vrije keuze informatiedeling	-
Sales Manager	Traceerbaarheid product	Traceabilityverplichtingen en bewijsvoering
Sales Manager	Onafhankelijk keuzes maken	-
Sales Manager	Systeem ondersteunend	Gebruik en rol van systemen
Sales Manager	Wettelijke vereisten	Wet- en regelgeving
Legal	Externe partij heeft geinformeerd	Externe informatiebronnen
Legal	Vertaalslag voor organisatie	Vertaling naar beleid en interne communicatie
Legal	Bekendheid binnen organisatie	Vertaling naar beleid en interne communicatie
Legal	Implicatie van verordening	Juridische en operationele verplichtingen
Legal	Controle verordening	Juridische en operationele verplichtingen
Legal	Verantwoordelijkheid verordening	Vertaling naar beleid en interne communicatie
Legal	Compliance in ketensamenwerking	Juridische en operationele verplichtingen
Stuurman	Visserijquota & vangstlimieten	Dataverwerking & digitale workflows
Stuurman	Discardban (aanlandplicht)	Dataverwerking & digitale workflows
Stuurman	Technische eisen aan vistuig	Organisatorische impact
Stuurman	Verplichtingen voor dagelijkse rapportage	Administratieve druk
Stuurman	Technische veiligheids- en onderhoudseisen	Complexiteit & strengheid van regelgeving

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Table D.1 – continued from previous page

Deelnemer	Code	Thema
Stuurman	Europese harmonisatie van regels	Multi-level governance
Stuurman	Gegevensdoorstroom tussen lidstaten	Multi-level governance
Stuurman	Digitale datastroom & rapportageketen	Dataverwerking & digitale workflows
Stuurman	Onzekerheden & uitzonderingen in datacodering	Dataverwerking & digitale workflows
Stuurman	Verantwoordelijkheden & rolverdeling	Organisatorische impact
Stuurman	Administratieve belasting	Administratieve druk
Stuurman	Hybriditeit van papier + digitaal	Systeemintegratie & digitalisering
Stuurman	Parallelle systemen	Systeemintegratie & digitalisering
Stuurman	Nieuwe technologie aan boord	Digitale transformatie
Stuurman	Toename in administratieve druk	Administratieve druk
Stuurman	Voordelen digitale systemen	Digitale transformatie
Visverwerker	Impact werkzaamheden	Organisatorische impact
Visverwerker	Hele keten / sector	Traceability & regelgeving
Visverwerker	Extra informatie vereisten	Traceability & regelgeving
Visverwerker	Extra informatie delen	Administratieve druk
Visverwerker	Onduidelijke richtlijnen uit wetgeving	Communicatie & beleid
Visverwerker	Niet voorbereidt voor aanpassingen	Organisatorische impact
Visverwerker	Controle / extra werkzaamheden	Datakwaliteit & governance
Visverwerker	Geen waarde voor organisatie	Administratieve druk
Visverwerker	Vaste manier van werken	Digitale workflows & automatisering
Visverwerker	Technologische middelen	IT-capaciteit & systeemgebruik
Visverwerker	Noodzakelijke menselijke handelingen	Digitale workflows & automatisering
Visverwerker	Gesegregeerde systemen	Systeemintegratie
Visverwerker	Onduidelijke richtlijnen uit wetgeving	Fragmentatie & silo's
Visverwerker	Onduidelijke richtlijnen uit wetgeving	Digitalisering & ketensamenwerking

Table D.2: Overview of Interview Themes and Clusters

Interviewee	Theme	Cluster
Sales Manager	Regionale verschillen in traceability-eisen	Regionale aspecten
Sales Manager	Traceabilityverplichtingen en bewijsvoering	Traceability & regelgeving
Sales Manager	Administratieve impact	Administratieve druk
Sales Manager	Afhankelijkheid per regio	Regionale aspecten
Sales Manager	Gebruik en rol van systemen	IT-capaciteit & systeemgebruik
Sales Manager	Wet- en regelgeving	Traceability & regelgeving
Legal	Externe informatiebronnen	Externe informatiebronnen

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Table D.2 – continued from previous page

Deelnemer	Thema	Cluster
Legal	Vertaling naar beleid en interne communicatie	Communicatie & beleid
Legal	Juridische en operationele verplichtingen	Traceability & regelgeving
Stuurman	Dataverwerking & digitale workflows	Digitale workflows & automatisering
Stuurman	Organisatorische impact	Organisatorische impact
Stuurman	Administratieve druk	Administratieve druk
Stuurman	Complexiteit & strengheid van regelgeving	Traceability & regelgeving
Stuurman	Multi-level governance	Organisatorische impact
Stuurman	Systeemintegratie & digitalisering	Systeemintegratie
Stuurman	Digitale transformatie	Digitale transformatie
IT-Manager	Communicatie & Informatievoorziening	Communicatie & beleid
IT-Manager	Governance & Compliance-processen	Organisatorische impact
IT-Manager	Huidige IT-capaciteiten & Sterktes	IT-capaciteit & systeemgebruik
IT-Manager	Fragmentatie & Data-inconsistentie	Fragmentatie & silo's
IT-Manager	IT-Awareness & Digitale Maturity	IT-capaciteit & systeemgebruik
IT-Manager	Fragmentatie & Organisatorische Silovorming	Fragmentatie & silo's
IT-Manager	Datakwaliteit & Procesrisico's	Datakwaliteit & governance
IT-Manager	Digitalisering & Ketensamenwerking	Digitalisering & Ketensamenwerking
IT-Manager	Organisatorische Structuur & Rollen	Organisatie & governance
IT-Manager	Integratie van Systemen (IT/OT convergence)	Systeemintegratie
IT-Manager	Operationele Digitalisering	Digitale workflows & automatisering
IT-Manager	Fragmentatie & Technische Silovorming	Fragmentatie & silo's
IT-Manager	Operationele Digitalisering / Automatisering	Digitale workflows & automatisering
IT-Manager	Data Governance & Security	Datakwaliteit & governance
IT-Manager	Organisatiedruk & Capaciteit	Administratieve druk
Visverwerker	Organisatorische impact	Organisatorische impact
Visverwerker	Traceability & regelgeving	Traceability & regelgeving
Visverwerker	Administratieve druk	Administratieve druk
Visverwerker	Communicatie & beleid	Communicatie & beleid
Visverwerker	Datakwaliteit & governance	Datakwaliteit & governance
Visverwerker	Digitale workflows & automatisering	Digitale workflows & automatisering
Visverwerker	IT-capaciteit & systeemgebruik	IT-capaciteit & systeemgebruik
Visverwerker	Systeemintegratie	Systeemintegratie

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Table D.2 – continued from previous page

Deelnemer	**Thema**	**Cluster**
Visverwerker	Fragmentatie & silo's	Fragmentatie & silo's
Visverwerker	Digitalisering & ketensamenwerking	Digitalisering & ketensamenwerking

Appendix E

Architecture Principles

Table E.1: Principles Overview

ID	Principle	Statement	Rationale	Implication	Domain	Relation to regulation	Source
1	Standardize where possible	Standardize where feasible, and specify where necessary	Standardization reduces variety and costs, ensures interoperability and security, and enhances agility. Choosing open standards helps prevent vendor lock-in	1. Use a current register of standards 2. Use open standards for modeling 3. Use standard solutions 4. Apply sector standards as required by laws and regulations	Applications	1. Regulation (EU) 1380/2013 2. Regulation (EU) 2023/2842	NORA Online. (2023). Standaardiseer waar mogelijk.

Continued on next page

ID	Principle	Statement	Rationale	Implication	Domain	Relation to regulation	Source
2	Security by design	Consider (cyber)security and privacy from the outset when designing processes, data, systems, and infrastructure	By incorporating security into the design, risks of data breaches, unauthorized access, and non-compliance are mitigated	1. Conduct a security assessment at the start of a new project or program 2. Raise awareness among employees and users about security risks due to negligence 3. Protect information proportionally to the associated risk	Applications & Infrastructure	1. AVG/GDPR — "privacy by design & by default" (Artikel 25) 2. NIS2	ISO/IEC 27001:2022 ISO/IEC 27002:2022
3	Promote interoperability	Processes, data, and systems should be designed to easily exchange information and collaborate	Interoperability prevents data from being locked in isolated systems and enables efficient collaboration with partners and regulators, enhancing transparency	1. Use open standards and uniform data models for data exchange 2. Document interfaces and APIs in a central catalog 3. Apply standardized protocols	Applications	EU (Regulation) 2023/2842	European Commission. (2017). European Interoperability Framework. The Open Group. (2018). TOGAF® Standard, Version 9.2.
4	Proactive compliance	Organizations should ensure continuous awareness of relevant laws and anticipate changes when designing and managing processes, data, systems, and infrastructure	Proactive insight allows timely adjustments, reducing non-compliance, fines, and delays	1. Establish processes to monitor new and changing laws and regulations 2. Conduct an impact analysis for new and changing laws and regulations	Business	-	In-depth Interviews

Appendix F

Good Practices

Table F.1: Good Practices Overview

ID	Name	Relation to principle	Derived from implication	Description	Impact	Source
1.1	Use a current register of standards	1. Standardize where possible	1.1	Ensure that all teams have access to a current register of standards. Check in new projects whether relevant standards are already available before developing custom solutions	Reduces duplication of work, promotes consistency, and facilitates interoperability between systems	NORA - Gebruik standaard oplossingen (implicatie)
1.2	Use open standards for modeling	1. Standardize where possible	1.2	Work according to an open standard for, among others, architecture, data, and process modeling. Examples: ArchiMate (architecture), UML (data), BPMN (processes)	Prevents vendor lock-in, facilitates collaboration between systems and organizations, and increases model reusability	NORA - Gebruik open standaarden voor modellering

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ID	Name	Relation to principle	Derived from implication	Description	Impact	Source
1.3	Evaluate standard solutions for implementation	1. Standardize where possible	-	Assess a standard solution for aspects such as security, interoperability, future-proofing, and vendor lock-in before adopting it	Reduces risks in management, integration, and long-term sustainability	-
1.4	Reuse over custom development	1. Standardize where possible	-	First assess whether existing components, standards, or services can be reused before developing new ones	Improves consistency and accelerates implementation by leveraging proven components and standards	-
2.1	Classify information by sensitivity	2. Security by design	2.3	Classify information objects into categories according to ISO 27001: public, internal, confidential, or secret. Apply security measures based on this classification.	Strengthens risk management and compliance by applying security measures in a targeted manner	ISO/IEC 27001 Annex A.5.12
2.2	Conduct a security and privacy assessment	2. Security by design	2.1	For every new project or system design, perform a risk assessment to identify security and privacy risks at an early stage. Document the results and use them to plan security measures	Enhances system security and privacy by early risk identification. Improves decision-making as measures are based on documented risk analyses	ISO/IEC 27005:2022
2.3	Ensure auditability and logging	2. Security by design	-	Log important actions and system events in a structured manner so they are traceable for audits and security investigations. Ensure that logs are protected and only accessible to authorized personnel	Facilitates the detection and investigation of security incidents during forensic analysis	ISO/IEC 27002:2022 A.8.15
3.1	Use standardized protocols for data exchange	3. Promote interoperability	3.1	When designing systems, adhere to standardized protocols to enable data exchange. Examples: REST, JSON, XML, or sector-specific standards	Ensures that systems have standardized protocols for exchanging data	-

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ID	Name	Relation to principle	Derived from implication	Description	Impact	Source
4.1	Monitor laws and regulations	4. Proactive compliance	4.1	Establish a process to continuously track new and amended laws and regulations through official sources, industry associations, and government updates. Document relevant changes and communicate them to the relevant teams	Ensures the organization stays informed in a timely manner, preventing non-compliance and fines	Interview fragment
4.2	Compliance impact analysis	4. Proactive compliance	4.2	For every significant change in laws or regulations, conduct an impact analysis on processes, systems, and data. Identify risks and necessary adjustments	Helps prioritize actions and minimizes operational disruptions	Interview fragment
4.3	Compliance key users	4. Proactive compliance	-	Appoint a key user in each business unit who is involved in significant changes in laws and regulations. This person should be engaged in implementing changes arising from the legislation	Provides authority within business units to apply legal requirements in processes, data, systems, or infrastructure	Interview fragment

Appendix G

Architecture Principles and Good Practices Documentation

Architecture Principles & Good Practices

Practical guidelines for enterprise architecture in the fisheries sector

Prepared as part of the research into a reference architecture for the fisheries sector

2026-03-06

Introduction

As an organization grows, its environment becomes increasingly diverse and complex. Added to this is often the influence of government regulations and policies, which further complicates decision-making. Industry-wide guidelines can provide support in this context and ensure uniformity.

This document serves as a reference for that purpose. It contains guidelines for designing and implementing new or existing systems, ensuring that consistent choices are made throughout this process, which enhances coherence within an organization. The ideas in this document offer recommended methods for structuring processes, systems, and data in the fisheries chain. They are not mandatory but serve as practical tools.

A reference architecture does not consist solely of models of business activities. Surrounding these models are also documents that define the scope and provide guidance to architects. To prevent design decisions from being made repeatedly, guidelines and frameworks have been established.

The scope and terminology of the document are explained first. This is followed by a more in-depth exploration of the concepts with examples.

Framework and Definition

Scope

This document is written with organizations in the fisheries sector in mind. It forms part of the reference architecture developed as part of research into enterprise architecture for the sector.

The scope focuses on the entire fisheries value chain—from ship to shelf—for fish products from the Dutch pelagic fisheries that fall under European legislation. The emphasis is on compliance with EU Regulation 2023/2842 (in particular Articles 56 and 58 on traceability) and its impact on processes, systems, and IT infrastructure.

The document does not address technical implementation or commercial decision-making, but rather focuses on generic principles and good practices applicable within the sector. These sections also highlight other industry standards that may be used.

Definition

An **architecture principle** is an important agreement that defines how something should be structured. It helps guide decisions regarding processes, information, and systems. By nature, an architecture principle is abstract and fundamental; it indicates what should be aimed for.

A **good practice** is a recommended method or approach for effectively applying an architecture principle in practice. It specifies the "how" of the principles, making them practical and concrete.

"The principle defines what is important; the good practice demonstrates how to implement it"

It can therefore be said that good practices provide the practical implementation of principles. The two complement each other: without principles, good practices are isolated actions lacking direction; without good practices, principles remain abstract guidelines that are difficult to implement.

Architecture Principles

An **architecture principle** is an agreement that defines how something should be structured. They are important because they provide a framework for decision-making, behavior, and achieving goals by promoting a consistent approach. They help guide choices regarding processes, information, and systems, ensuring that these decisions are both consistent and purposeful. Using principles makes it easier to align processes and systems with one another.

Although principles can be abstract, they offer guidance for approaching matters consistently. They provide direction without prescribing every detail, allowing organizations the flexibility to apply tailored solutions. Architecture principles are formulated in a standardized way:

Name	A short and clear designation of the principle, making it easy to remember and communicate.
Statement	The core message of the principle: a clear, unambiguous statement that provides guidance.
Rationale	The motivation and added value of the principle: why it is important and which problem or objective it supports.
Implications	The motivation and added value of the principle: why it is important and which problem or objective it supports.
Relation to Regulations	Optional, e.g., EU 2023/2842 Article X

An example of an architecture principle is formulated below:

Name	**Reuse over Customization**
Statement	Organizations and systems should use existing standards, components, or services wherever possible before developing custom solutions.
Rationale	Custom solutions increase complexity, create dependency on specific vendors, and raise maintenance overhead. By using reusable components and standards, costs can be controlled, consistency ensured, and interoperability between systems improved.
Implications	• New functionality should first be evaluated against existing solutions or standards. • Development teams must document why customization is necessary if existing components are insufficient. • Custom solutions should only be applied when demonstrably necessary and approved by an authorized person.
Relation to Regulations	Not applicable

Good Practices

In a reference architecture, architecture principles are linked to good practices. The principle defines what is important, while the good practices indicate how this can be implemented in concrete terms.

Good practices are therefore methods or approaches for applying architecture principles in practice. They provide guidance on how organizations can structure processes, systems, and information to comply with the principles.

They are important because they help bridge the gap between theory and practice. They ensure that principles do not remain merely on paper but are actually applied, promoting uniformity, efficiency, and compliance.

Similar to principles, good practices can be formulated in a standardized way:

Name	A short, clear, and recognizable name that summarizes the core of the good practice
Relation to Principle	The architecture principle on which the good practice is based or which it supports.
Description	A concise explanation of what should be done in practice to implement the principle.
Impact	An explanation of the added value or effects of applying the good practice.

The following is an example of a good practice based on the previously provided architecture principle:

Name	**Use Existing Components and Standards**
Relation to Principle	Reuse over Customization.
Description	Before developing new functionality, existing components, standards, or services should first be evaluated for reuse. Document why customization is necessary if existing solutions are insufficient. Apply custom solutions only when demonstrably required and have them approved by the project lead or team manager.
Impact	• Reduces dependency on specific vendors. • Limits maintenance overhead and costs associated with custom solutions. • Improves consistency and interoperability between systems across the value chain. • Accelerates implementation by leveraging proven components and standards.

Appendix H

Viewpoints

Compliance & Sector Communication Viewpoint	
Stakeholders	RVO, NVWA, RVZ, Visfederatie, Legal
Concerns	1. Accurate and timely information on laws and regulations for all relevant stakeholders 2. Consistent sector-wide guidelines and communication 3. Reliable registration and availability of systems and data
Purpose	Informing, designing
Scope	Business Layer, Data Layer, Application Layer
Representation	ArchiMate
Views	1. Regulation Development Workflow View 2. Regulation Implementation Workflow View 3. Regulatory Information Objects View
Elements	1. Business Process, Business Actor, Business Service 2. Business Process, Business Actor, Business Service 3. Business Process, Business Object, Application Component, Constraint

Table H.1: Compliance & Sector Communication Viewpoint

This viewpoint focuses on the processes organizations must follow to achieve regulatory compliance. It addresses how regulations are developed, the communication between regulators and stakeholders, and provides an overview of all information objects required to comply with regulations. The primary concern addressed is ensuring that organizations have access to accurate and upto-date regulatory information. Organizations often struggle to stay informed about new or updated regulations and to understand how to translate these requirements into actionable procedures. This viewpoint includes three views: the development of regulations, their implementation, and an overview of the information objects required by regulations. These views aim to support organizations in the fisheries sector by providing accurate and timely information on laws and regulations, and by promoting a consistent communication process for sector-wide guidelines.

Compliance Process Viewpoint	
Stakeholders	Officer, Quality Manager, Logistics, Fish Processor, Sales, Export
Concerns	1. Accurate and complete catch and production data by all relevant actors 2. Proper compliance with traceability and regulatory requirements 3. Efficient and error-free process management in administration and workflows 4. Reliable IT support and consistent reporting 5. Clear interpretation and communication of rules 6. Handling regional differences in requirements
Purpose	Informing, Designing
Scope	Business Layer, Data Layer, Application Layer
Representation	ArchiMate
Views	1. Compliance Workflow View 2. Information Flow View 3. Systems & Integration View
Elements	1. Business Actor, Business Process, Business Object, Application Component 2. Business Process, Business Object, Application Service, Application Component 3. Application Component, Application Service

Table H.2: Compliance Process Viewpoint

The Compliance Process Viewpoint provides an overview of the key activities in the fisheries supply chain that generate traceability-relevant information. It shows how these activities produce, maintain, and share data needed to comply with regulations. The viewpoint also illustrates how information objects relate to each other and how supporting software systems interact. This integrated perspective helps stakeholders understand the flow of critical compliance data across the supply chain. Stakeholders face challenges ensuring that traceability information is accurate, complete, and compliant with regulations. Without a clear overview of which activities produce compliancecritical data, or how this data is shared and interpreted, errors, inefficiencies, and potential noncompliance can occur. This viewpoint highlights where and how compliance information is generated, so all actors can coordinate their actions effectively and reduce miscommunication or mistakes. This viewpoint focuses only on activities, information, and systems that are essential for traceability compliance. Other business processes, data, or systems that do not directly 10 contribute to regulatory compliance are intentionally excluded. This ensures that the viewpoint is clear, focused, and provides stakeholders with a concise understanding of how compliance information flows and is managed throughout the fisheries supply chain.

System Landscape & Integration Viewpoint	
Stakeholders	Officer, Quality Manager, Logistics, Fish Processor, Sales, Export, IT
Concerns	1. Reliable and accessible systems for all supply chain actors 2. User-friendly systems and sufficient digital skills among users 3. Consistent and timely data exchange through proper system integration 4. Clear insight into and effective management of the overall system landscape
Purpose	Informing
Scope	Application Layer, Infrastructure Layer
Representation	ArchiMate
Views	1. System Landscape View 2. System Stakeholder Interaction View
Elements	1. Application Component, Application Service, Equipment, Node, Facility, Technology Service 2. Business Actor, Application Component, Application Service

Table H.3: System Landscape & Integration Viewpoint

The System Landscape & Integration Viewpoint provides an overview of the systems within the fisheries sector, including their services and the interactions between actors. It focuses on the application and infrastructure layers, giving stakeholders a clear understanding of the system landscape and its management. Stakeholders require systems that are accessible, user-friendly, and capable of exchanging consistent and timely information across the supply chain. A clear overview of the overall system landscape is essential to support management and decision-making. The viewpoint highlights the application components and services that are relevant across the sector. Generic enterprise services, such as procurement or warehouse management, are included only at an abstract level to provide contextual completeness. These services are not modeled in detail, as they fall outside the scope.

Information Model Viewpoint	
Stakeholders	ICT, Management, Fleet Management, Trade Association
Concerns	1. Uniform and consistent information concepts across the sector 2. Reliable and accurate data for reporting, decision-making, and compliance 3. Clear governance and standards for data and systems 4. Avoidance of fragmentation and silos between systems and departments
Purpose	Informing
Scope	Business Layer
Representation	ArchiMate
Views	1. Core Information View 2. Information Object Hierarchy View 3. Information Standards & Structures View
Elements	1. Business Object 2. Business Object 3.Business Object, Requirement

Table H.4: Information Model Viewpoint

The Information Model Viewpoint provides a clear overview of the key information objects used across the Dutch pelagic fisheries sector. It shows how data is structured, related, and organized to support reporting, and decision-making. The viewpoint also highlights relevant standards and how they can be applied consistently, helping stakeholders understand what information is critical and how it should be managed. Information objects in the sector are often inconsistent or unclear, which can lead to errors, misinterpretations, and fragmented reporting. Without a uniform understanding of data and its relationships, stakeholders may struggle to comply with regulations, make informed decisions, or share information effectively. This viewpoint addresses these challenges by presenting a structured and standardized representation of key information. This viewpoint focuses only on the core information objects and their relationships in the sector. It excludes detailed operational processes and systems. By concentrating on essential data structures and standards, stakeholders gain a clear, high-level view of how information is organized and governed across the sector

Appendix I

Views

I.1 Compliance & Sector Communication Viewpoint Views

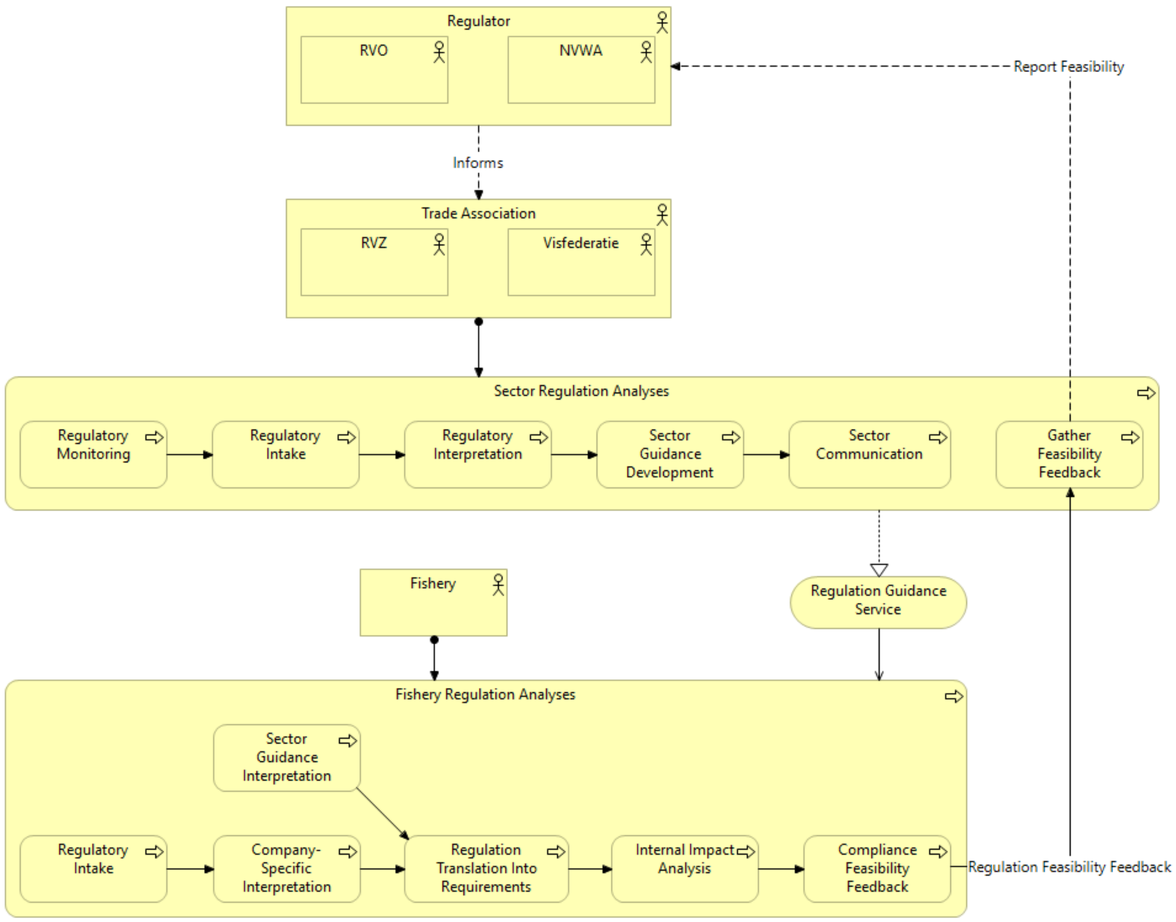

Figure I.1: Regulation Development Workflow View

The Regulation Development Workflow View shows the workflow for regulation development, showing how regulators, trade associations, and fisheries collaborate to interpret and communicate new regulations. Regulators inform trade associations about upcoming regulations with a draft version. They interpret this and develop a draft version of sector guidelines. These guidelines are exchanged with fisheries, members of the trade association, to inform them of upcoming regulations. Fisheries are then expected to use these guidelines, in combination with their own interpretation, to translate them into business requirements and use this to analyze the impact on the business' operations. Finally, fisheries are expected to communicate feedback on the feasibility of upcoming regulations. Trade associations gather this feedback and discuss this with regulators. 8 This process ensures that the sector is informed and engaged throughout regulatory development. Uniform guidelines are created iteratively, with a feedback loop that helps ensure regulations are developed fairly and consider the interests of all stakeholders.

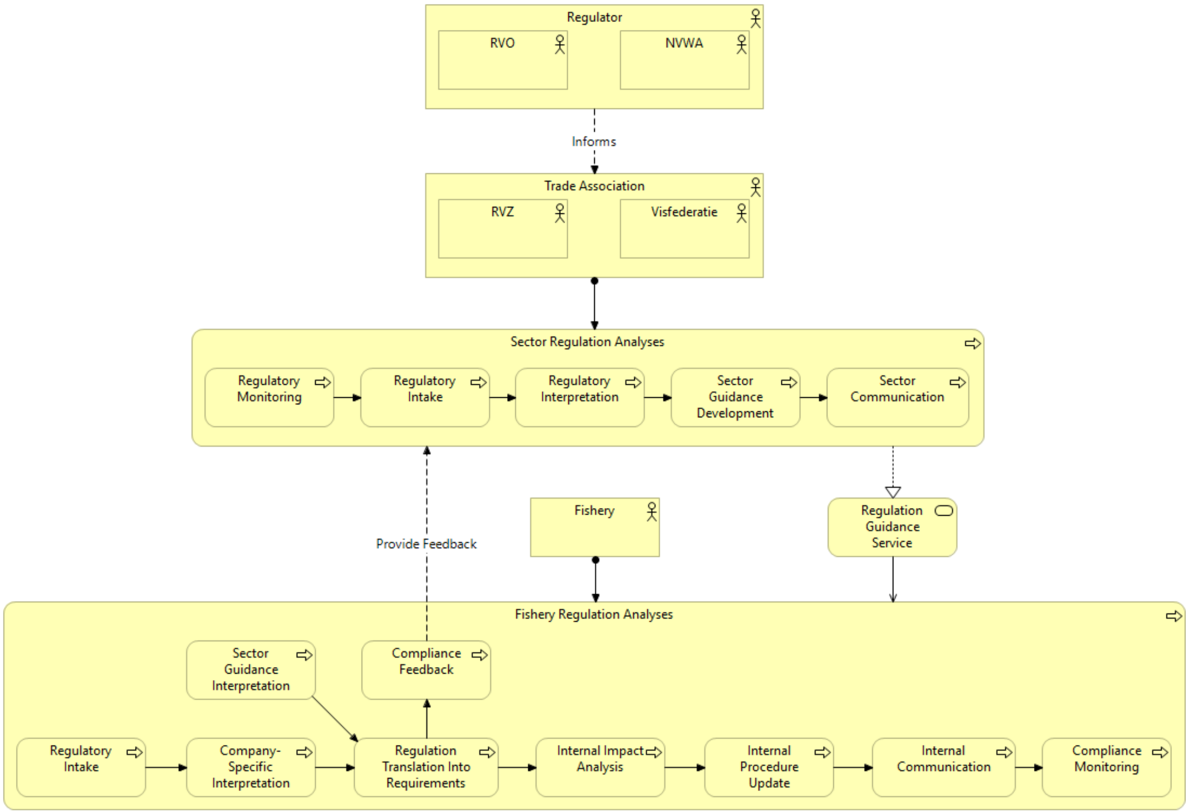

Figure I.2: Regulation Implementation Workflow View

Similar to the Regulation Development Workflow View, the Regulation Implementation Workflow View focuses on the implementation of regulations rather than their development. It guides organizations through the activities, processes, and adjustments needed to comply with regulatory requirements. Trade associations receive regulatory information from regulators and use it to develop sector guidelines. Fisheries interpret these guidelines and the regulations themselves, translate them into organizational requirements, and conduct an impact analysis to assess operational implications. Based on this, internal procedures - including processes, systems, and infrastructure - are adjusted to achieve compliance. Internal communication and monitoring are essential to ensure consistent adherence. Fisheries may also provide feedback to trade associations regarding the clarity or feasibility of the compliance guidelines. Similar to the Regulation Development Workflow View, the Regulation Implementation Workflow View shows the process organizations follow to achieve regulatory compliance. It highlights the operational steps, feedback loops, and responsibilities needed to maintain consistent adherence across the sector.

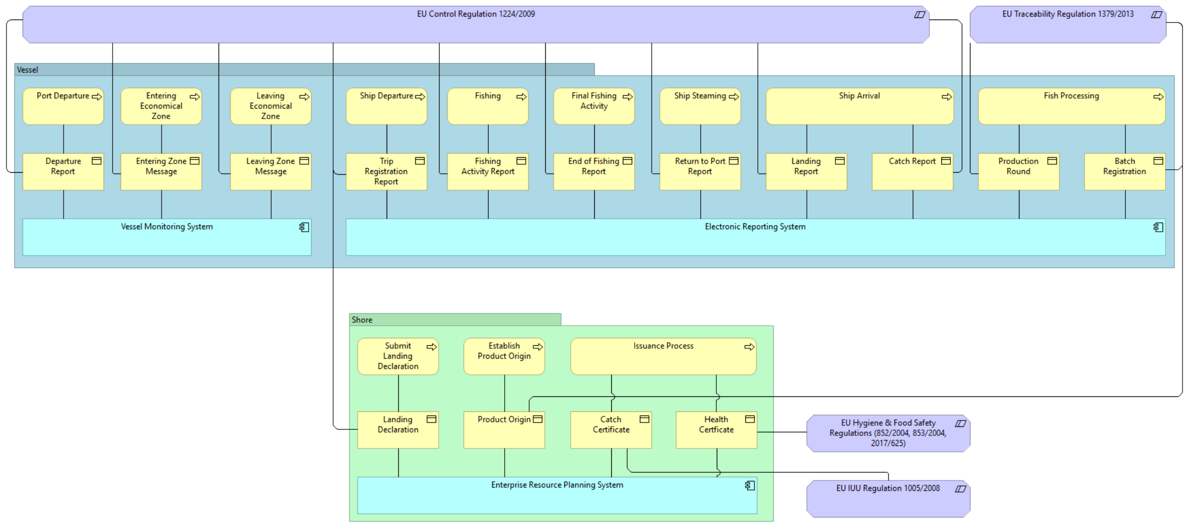

Figure I.3: Regulatory Information Objects View

The Regulatory Information Objects View focuses on the key information objects that are relevant for regulatory compliance across the fisheries supply chain. It shows how these information objects relate to their regulatory counterparts and the processes and systems that manage them. This view identifies and maps the main information objects used to support compliance activities, such as reports, logs, and notifications. It illustrates how each object is linked to regulatory requirements and indicates which systems and processes are responsible for creating, storing, or processing them. The view provides a clear understanding of data flow and traceability within the sector.

I.2 Compliance Process Viewpoint Views

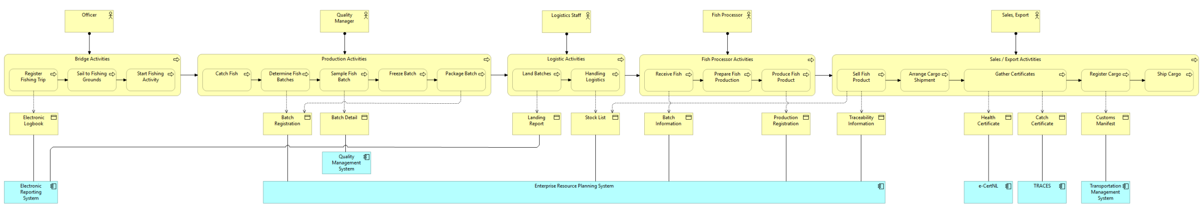

Figure I.4: Compliance Workflow View

The Compliance Workflow View covers the key activities required to generate traceability information for compliance. The activities illustrate when specific information objects are generated and which systems support their creation and management. The view focusses on the key activities needed to be performed for traceability compliance: 1) Onboard activities; during a fishing trip, the vessel keeps track of operations using an electronic logbook. Fish batches are registered separately as they are caught, with details including catch area, species, fishing equipment, and attributes such as length, average weight, roe, and fat percentage. 2) Landing and stock management; Once the vessel arrives at shore, a landing report is generated for regulators. Stowing fish produces a final stock list, which is also used for commercial purposes. 3) Processing (optional); Fish processors may transform raw fish into new products. Batch information is carried forward, and new traceability data is generated during processing. 4) Sales and freight; To sell fish products, traceability information must be available. Freight arrangements are made, and depending on the destination, product certification is required. Required documents are collected and submitted to customs before shipment. The Compliance Workflow View shows the main steps in the fisheries supply chain that are needed to create traceability information. It ensures that all actors record catch, production, and processing data accurately, supporting compliance with traceability and regulatory rules. The view highlights the important activities and their order, and it shows which systems support these activities, including optional steps or regional differences, such as export certifications. Overall, this view guides all actors on which activities generate traceability information, what information is needed, and how systems help manage these processes, making it easier to work consistently.

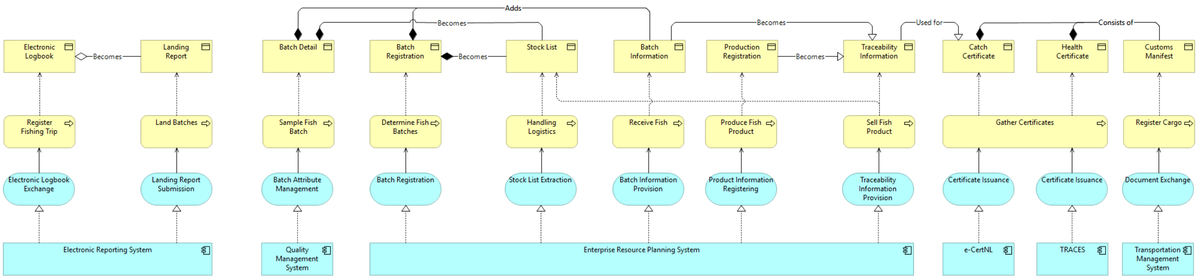

Figure I.5: Information Flow View

The Information Flow View focusses on how information objects are related to each other. Relationships are shown along with the supporting processes and the systems that provide them. The view shows the relationship between the electronic logbook and the landing report, where the landing report is derived from the information recorded in the electronic logbook. The stock list is derived from batch registrations and their associated batch details and is used to support sales activities. These two batch components become batch information, which is reused consistently throughout the chain. When raw fish products are processed, batch information combined with production registrations generates new traceability information describing the origin and transformation of the fish products. This traceability information spans the entire supply chain, covering all relevant data from the initial catch to products sold to retailers or exported. The same 11 information can also be used for certification purposes, which may be required for customs declarations when exporting goods internationally. By making clear how information objects are generated, transformed, and shared, the view helps ensure accurate and complete data, supports compliance with traceability and regulatory requirements, and enables efficient, reliable workflows

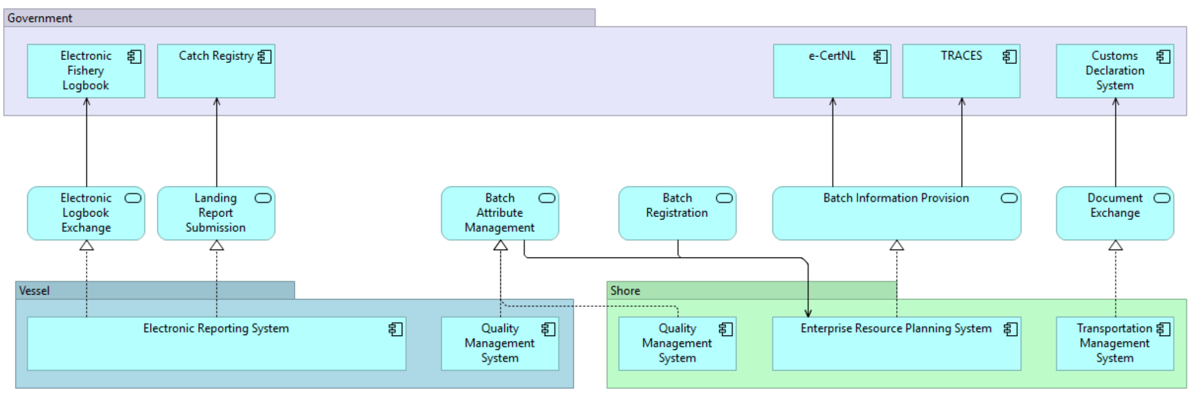

Figure I.6: Systems & Integration View

The Systems & Integration View presents the application components (software systems) and their services that are relevant for traceability compliance. Each application component provides specific services that connect it to other components, enabling the flow of information across the system landscape. The view illustrates how an electronic reporting system is connected to government systems responsible for storing the electronic logbook and managing the catch registry for quota control. It also shows the application services that support the creation of complete batch information, which is gathered from multiple systems. Systems responsible for certificate issuance and customs declarations are included as well. This view clarifies which application components are involved in traceability compliance and the services they provide. By making these connections visible, stakeholders can rely on consistent IT support and reporting, ensuring that the systems effectively support compliance and operational processes.

I.3 System Landscape & Integration Viewpoint Views

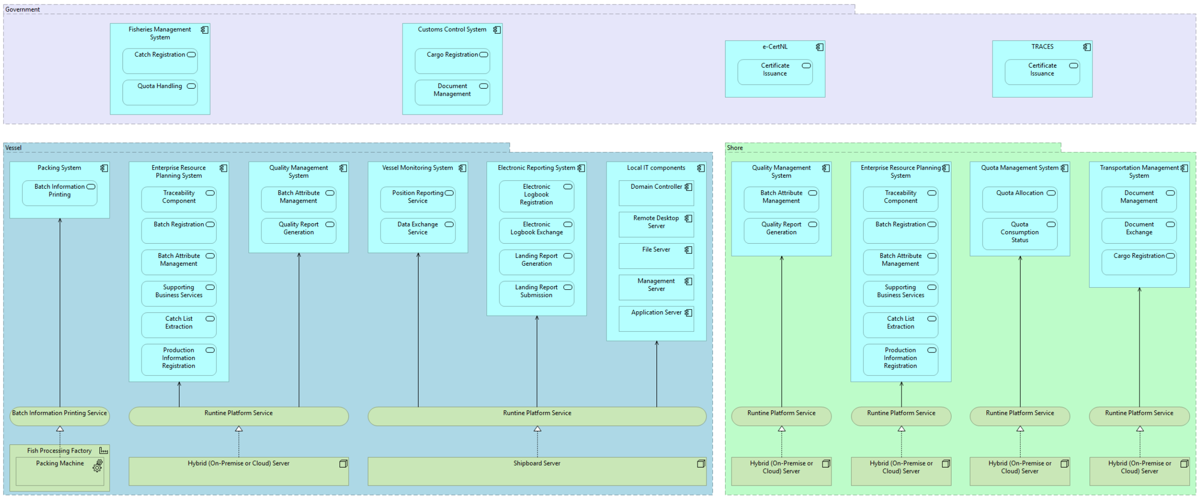

Figure I.7: System Landscape View

The System Landscape View provides an overview of the key application systems and supporting infrastructure across the fisheries sector, including government, vessel-based, and shore-based environments. In addition, it highlights the most relevant application services provided by these systems. The view is structured into three main sections, starting with vessel-related components. Within this section, three infrastructure platforms support various application components. Each application component represents a system, while the functionality of these systems is expressed through application services. Broader application components are supported by a hybrid server, enabling organizations to choose between on-premise, cloud-based, or hybrid deployments. This infrastructure forms a single virtualized instance that can host multiple application components. On board the vessel, a shipboard server supports applications that must operate locally, while also allowing for hybrid 13 configurations where applicable. Operational Technology (OT) supports the packing system, which is used for printing batch information on cartons. The same overview is done for application components that are used on shore. However, each system has its own infrastructure that supports individual application components. This indicates that each application component has its own underlying infrastructure. Finally, several government application components are included, focusing on the functionality relevant to fisheries stakeholders. Supporting infrastructure for government systems is intentionally excluded, as these elements fall outside the responsibility and influence of actors within the fisheries sector. By providing a consolidated overview of systems, their functionality, and supporting infrastructure, this view offers stakeholders clear insight into the existing system landscape. This facilitates more informed decision-making regarding system management and integration, and supports initial alignment efforts across organizations.

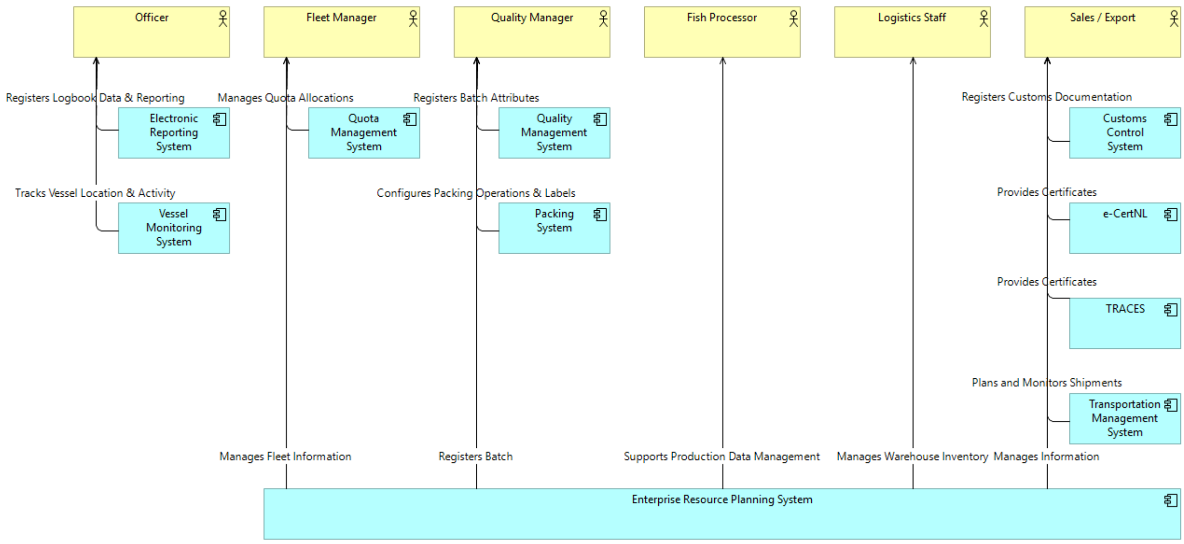

Figure I.8: System Stakeholder Interaction View

The System Stakeholder Interaction View provides an overview of the main actors in the supply chain and illustrates how they interact with the various application components within the system landscape. The view highlights which systems are used by which stakeholders and for what purposes. In the System Stakeholder Interaction View, it becomes clear how each actor depends on reliable and accessible systems to carry out their daily tasks, while the visualisation of user–system interactions also shows where usability and digital skills may influence how effectively these tools are used.

I.4 Information Model Viewpoint

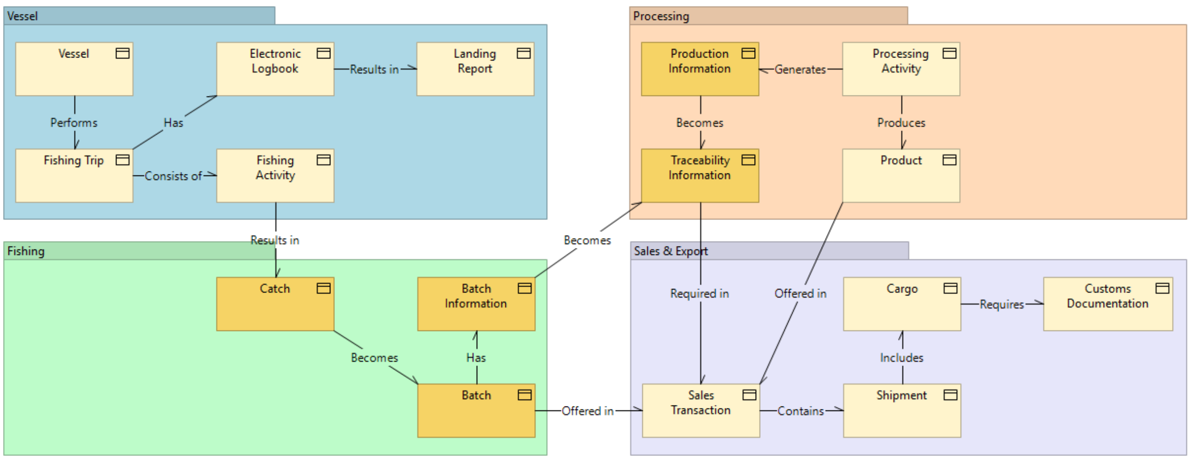

Figure I.9: Core Information View

The Core Information View presents the primary information objects that underpin the key activities within the Dutch pelagic fisheries sector. It provides a sector-level overview of how information is generated, transformed, and exchanged throughout the operational and commercial lifecycle. The view is structured into four main sections representing different stages of the value chain: vessel operations, fishing activities, processing, and sales & export. Each section contains the core information objects that define its processes and responsibilities. Within the vessel domain, a Fishing Trip consists of one or more Fishing Activities, which are recorded in an Electronic Logbook and ultimately result in a Landing Report. The fishing section 15 captures how a Catch is generated and transformed into a Batch, which is then enriched with Batch Information. In the processing section, Batch Information becomes Traceability Information, supplemented with Production Information and Production Activities that generate final Products. The sales and export section shows how these Products are included in shipments and cargo, forming part of a Sales Transaction, which in turn requires supporting Customs Documentation. Together, these elements describe the essential information flow from vessel activities through harvesting, processing, and export. The view highlights how information objects evolve and relate to one another, forming the backbone of the sector's operational data landscape. The Core Information View supports the sector's concerns by providing a uniform and consistent foundation for key information concepts, ensuring that data is organized in a reliable and accurate way for reporting, decision-making, and compliance. By clarifying which core information objects exist and how they relate across operational domains, the view contributes to clearer governance and reduces the risk of fragmented or siloed information within and between organizations.

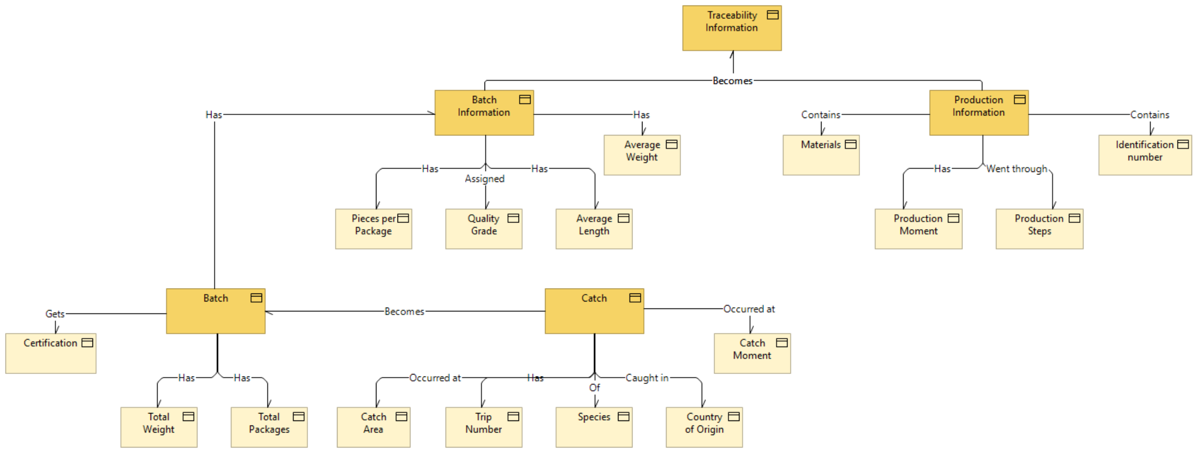

Figure I.10: Information Object Hierarchy View

The Information Object Hierarchy View illustrates how key information objects relate to one another through a structured hierarchy. The view provides insight into how lower-level information objects and their attributes build up to more aggregated objects, ultimately supporting traceability across the value chain. The view presents five primary information objects, each expanded with relevant attributes to show their internal structure and relationships. These information objects are arranged hierarchically, demonstrating how data moves and transforms throughout the product lifecycle. Lower-level objects such as Catch and Batch contribute their attributes upward, meaning that higher-level objects—most notably Traceability Information—inherit all underlying information needed for complete and verifiable traceability. The hierarchy also clarifies how objects evolve or become part of other objects. For example, Catch becomes part of a Batch, and Batch later becomes Batch Information, which may include assigned attributes like quality grade, pieces per package, or average weight. In parallel, Production Information contributes additional details such as materials, production steps, and identification numbers. Ultimately, all these elements converge in Traceability Information, providing a consolidated and comprehensive overview. This hierarchical representation highlights the essence of structured information flow in the context of batch-based production and reporting. It shows not only the relationships between information objects but also the logic behind how these objects accumulate attributes to support end-to-end visibility. The hierarchy supports uniform and consistent information concepts, as it clearly defines how each object relates to others and what attributes they include. It contributes to reliable and accurate data, since data is systematically built up from well-defined components. 16 The structure provides clear governance and standards by enforcing a coherent approach to how information must be organized and inherited. By visualizing how information objects integrate rather than exist in isolation, the view helps prevent fragmentation and siloed data, promoting interoperable and connected information flows.

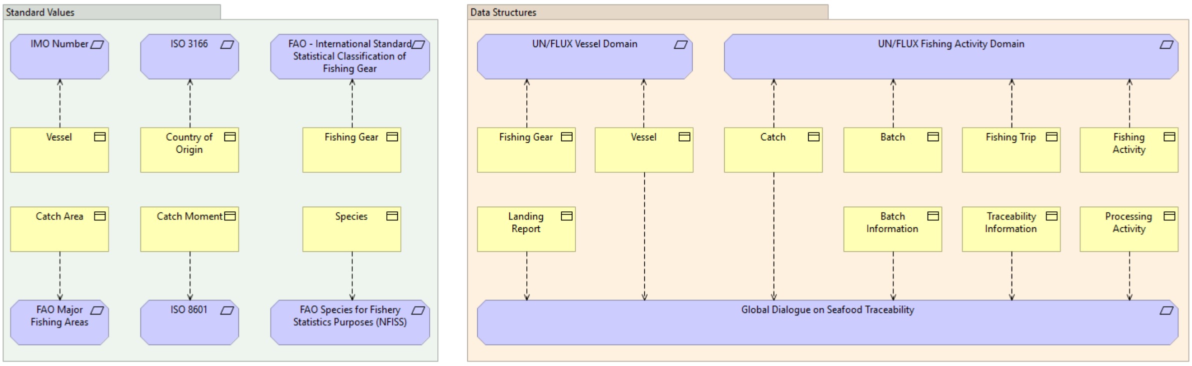

Figure I.11: Information Standards & Structures View

Organizations in the fisheries sector have already developed data standards and structures for others to use. The Information Standards & Structures View shows some of the key information objects and possible data standards or structures that organizations can use for their own implementation. The sources of the standard values and data structures are provided in Appendix B 1 Data Standard Sourcesand Appendix B 2 Data Structure Sources. The view is split into two sections. The first one contains standard data values that have been institutionalized in the sector, such as pre-defined fishing grounds or fishing gear. This shows which attributes have already been developed/institutionalized throughout the sector. This way, organizations do not need to develop their own data values. The second part shows data structures that have already been developed for the fisheries sector. This has been done by government bodies or non-profit organizations that try to unify/institutionalize data structures throughout the sector. This way, organizations do not need to develop their own data structures. The Information Standards & Structures View strengthens sector-wide consistency by enabling all organizations to reuse the same standardized values and data structures. It provides clear governance through formalized standards, including transparency about their sources, ownership, and scope. By relying on classifications and data models, the view enhances the reliability, accuracy, and auditability of information used for reporting, compliance, and traceability. Finally, it helps prevent fragmentation by ensuring that both internal departments and external partners work with unified definitions and interoperable data structures.

Appendix J

Terminology

Table J.1: Terminology Overview

Begrip	**Definitie**	**Afkor-ting**	**Concept**	**Definition**
Enterprise Architectuur	Het samenhangend geheel van principes, modellen en afspraken dat de structuur en werking van een organisatie beschrijft, inclusief processen, informatie, applicaties en technologie	EA	Enterprise Architecture	A coherent set of principles, models and agreements describing the structure and operation of an organization, including processes, information, applications and technology
Referentie Architectuur	Een generieke architectuur die best practices, principes en structuren vastlegt en als richtlijn dient voor het ontwerpen van specifieke architecturen binnen een domein	RA	Reference Architecture	A generic architecture capturing best practices, principles and structures to guide the design of domain-specific architectures
Batch	Een verzameling gegevens of producten die als één geheel wordt verwerkt of gevolgd binnen een proces	–	Batch	A collection of data or products processed or traced as a single unit
Fishing Activity Report	Dagelijks automatisch rapport dat gedeeld wordt met overheidsinstellingen over de activiteiten van het vissen	FAR	Fishing Activity Report	Daily automated report shared with authorities describing fishing activities
Traceerbaar-heid	Het vermogen om zowel fysieke producten als de bijbehorende digitale gegevens te volgen en te traceren in de gehele keten	–	Traceability	The ability to track and trace both physical products and their associated digital data throughout the supply chain
Informatie-object	Een logisch gedefinieerd stuk informatie dat wordt gebruikt of uitgewisseld tussen systemen	–	Information Object	A logically defined piece of information used or exchanged between systems
Inter-operabiliteit	Het vermogen van systemen om informatie correct te delen en te gebruiken	–	Inter-operability	The ability of systems to exchange and correctly use information
Systeem-landschap	Overzicht van systemen en hun onderlinge relaties binnen een domein	–	System Landscape	An overview of systems and their relationships within a domain

Continued on next page

Table J.1 – continued from previous page

Begrip	Definitie	Afkor-ting	Concept	Definition
Integratie	De technische en functionele koppeling tussen systemen	–	Integration	The technical and functional connection between systems
Viewpoint	Een perspectief dat bepaalt welke elementen en relaties in een view worden opgenomen	–	Viewpoint	A perspective defining which elements and relationships are included in a view
View	Een concrete weergave van een systeem of domein vanuit een bepaald viewpoint	–	View	A concrete representation of a system or domain from a specific viewpoint
Stakeholder	Actor met een belang bij de architectuur of het systeem	–	Stakeholder	An actor with an interest in the architecture or system
Concern	Een belang, probleem of aandachtspunt van een stakeholder	–	Concern	An interest, problem or issue relevant to a stakeholder
Regelgeving-compliance	Het voldoen aan wet- en regelgeving	–	Regulatory Compliance	Adherence to laws and regulations
Good Practice	Beproefde aanpak die effectief blijkt in de praktijk	–	Good Practice	A proven approach that has shown to be effective in practice
Referentie model	Abstract model dat concepten en relaties binnen een domein beschrijft	–	Reference Model	An abstract model describing concepts and relationships within a domain
Governance	Sturing en besluitvorming rond architectuur en IT	–	Governance	Steering and decision-making related to architecture and IT
Keten transparantie	Vastlegging van eigendom en overdracht van producten door de keten	–	Chain of Custody	The documentation of ownership and transfer of products throughout the supply chain
Illegale visserij	Illegale, ongemelde en ongereglementeerde visserij	IUU	IUU Fishing	Illegal, unreported and unregulated fishing
Architectuurprincipe	Een fundamentele richtlijn die richting geeft aan ontwerpkeuzes binnen de architectuur	–	Architecture Principle	A fundamental guideline that directs design decisions within an architecture

Appendix K

Expert Evaluation Questionnaire

Naam	
Functie	
Organisatie	
Datum	
Locatie	
Doelgroep	

Doel van het formulier

Dit formulier verzamelt feedback op de voorgestelde referentie architectuur. De feedback wordt gebruikt om de relevantie, duidelijkheid, compleetheid en toepasbaarheid van de architectuur te verbeteren.

Onderdelen

1. Probleemherkenning
2. Relevantie van de referentie architectuur
3. Duidelijkheid & begrijpelijkheid
4. Compleetheid
5. Praktische toepasbaarheid
6. Eindvragen

1. Deel A – Probleemherkenning

A1. In hoeverre herkent u het geschetste probleem in uw context?

1	2	3	4	5
Helemaal niet				*Volledig*

A2. Dit probleem is belangrijk om op te lossen.

1	2	3	4	5
Helemaal niet				*Volledig*

A3. De probleemomschrijving was duidelijk.

1	2	3	4	5
Helemaal niet				*Volledig*

A4. Zijn er aspecten van het probleem die u mist of anders ziet?

2. Deel B – Relevantie van de referentie-architectuur

B1. De architectuur adresseert het geschetste probleem effectief.

1	2	3	4	5
Helemaal niet				*Volledig*

B2. De voorgestelde oplossingen/structuren zijn relevant voor de sector / organisatie.

1	2	3	4	5
Helemaal niet				*Volledig*

B3. De referentie architectuur bevat de belangrijkste elementen die nodig zijn.

1	2	3	4	5
Helemaal niet				*Volledig*

B4. Wat vindt u het meest waardevolle onderdeel van de architectuur?

3. Deel C – Duidelijkheid & Begrijpelijkheid

C1. De architectuur was helder uitgelegd.

1	2	3	4	5
Helemaal niet				*Volledig*

C2. De visualisaties en modellen waren begrijpelijk.

1	2	3	4	5
Helemaal niet				*Volledig*

C3. De beschrijvingen waren concreet genoeg zonder te technisch te worden.

1	2	3	4	5
Helemaal niet				*Volledig*

C4. Welke onderdelen waren onduidelijk of missen toelichting?

4. Deel D – Compleetheid van de referentie architectuur

D1. De principes, kaders en modellen vormen samen een compleet geheel.

1	2	3	4	5
Helemaal niet				*Volledig*

D2. Er ontbreken geen belangrijke concepten.

1	2	3	4	5
Helemaal niet				*Volledig*

D3. Wat zou moeten worden toegevoegd om het geheel completer te maken?

5. Deel E – Praktische toepasbaarheid

(Gebruik dit deel specifiek voor interne stakeholders; voor externe kun je het optioneel maken.)

E1. Ik zie hoe deze architectuur toepasbaar is in mijn organisatie.

1	2	3	4	5
Helemaal niet				*Volledig*

E2. De architectuur lijkt haalbaar om in de praktijk te implementeren.

1	2	3	4	5
Helemaal niet				*Volledig*

E3. De voorgestelde architectuur past bij onze huidige strategie / systemen.

1	2	3	4	5
Helemaal niet				*Volledig*

E4. Wat is volgens u de grootste bottleneck voor implementatie?

6. Eindvragen

F1. Hoe waarschijnlijk is het dat u deze referentie architectuur zou aanbevelen aan andere organisaties in de sector?

1	2	3	4	5
Zeer onwaarschijnlijk				*Zeer waarschijnlijk*

F2. Wat is uw algemene oordeel over de referentie architectuur?

1	2	3	4	5
Zeer slecht				*Uitstekend*

F3. Heeft u nog overige opmerkingen, zorgen of aanbevelingen?

Appendix L

Complete Expert Evaluation Results

		Visfederatie	PFA / RVZ	IT-Manager	Vlootmanager A	Vlootmanager B	Duurzaamheidsadviseur	Juridisch	Sales Manager	Stuurman	Visverwerkings manager	Export medewerker	
Probleemherkenning	A1	4	4	5	3	4	4	4	2	4	4	3	3,73
	A2	4	4	4	4	5	4	4	2	4	5	4	4,00
	A3	4	5	4	4	4	4	5	3	4	4	5	4,18
	A4	-	Zelfde mechanisme voor voorgestelde regelgeving en positiebepaling daaromtrent van de sector	-	Nee	Compleet voor mij	Nee	-	Ik vind het probleem niet duidelijk omschreven	-	Nee, het lijkt mij compleet en duidelijk weergegeven	Nee	-
Relevantie	B1	4	5	3	4	4	4	4	3	4	4	5	4,00
	B2	5	5	4	4	4	4	4	4	5	5	5	4,45
	B3	4	5	4	5	4	3	4	4	4	4	5	4,18
	B4	Inzichtelijk brengen van de complexiteit, maar daarom juist het belang van actieve houding in de keten en samenwerking/terugkoppeling	Grafisch inzichtelijkheid	-	N.v.t.	Het bijhouden van veranderende regelgeving	Voornamelijk de workflow, waardoor verantwoordelijkheden en volgordelijkheid inzichtelijk worden	-	-	-	Dat het een juiste blauwdruk schets voor alle betrokken partijen. Het laat een uniforme aanpak zien wat in algemene zin toepasbaar is	De architectuur geeft inzicht aan collega's die niet bekend zijn met de gehele bedrijfsstructuur, waardoor meer begrip ontstaat.	-
Duidelijkheid & begrijpelijkheid	C1	4	5	4	5	4	4	5	4	5	5	5	4,55
	C2	4	5	4	4	5	5	5	3	5	5	5	4,55
	C3	4	5	4	4	5	3	4	4	4	5	5	4,27
	C4	-	-	-	Geen	-	Niks mist er, tijdens presentatie snel de diepte in waardoor het belangrijk is om stil te staan bij hoe onderwerpen en onderdelen zich tot elkaar verhouden	-	-	-	Geen. Duidelijk en helder verhaal.	Bepaalde termen zullen niet bij iedereen bekend zijn, hier zullen ze eerst wat voor moeten inlezen.	-
Compleetheid	D1	3	4	3	4	5	4	4	3	4	4	5	3,91
	D2	3	4	3	5	5	4	3	4	4	4	4	3,91
	D3	Objecten koppelen aan wetgeving -> dan kan je beargumenteren waarom het nodig is	(zie a4) grafische inzichtelijkheid	Modellen aanvullen. Praktijkvoorbeelden	Niet	-	Wellicht hoe afdelingen binnen een bedrijf veranderingen in wetgeving kunnen oppakken, ipv. Alleen als sector / branche.	-	-	-	Geen toevoeging benodigd.	Zou de uiteindelijke maker van de regelgeving (EU-brussel) nog toevoegen, verder compleet.	-
Praktische Toepasbaarheid	E1	-	5	4	4	4	4	4	4	4	3	-	4,00
	E2	-	5	4	3	4	3	4	3	3	4	-	3,67
	E3	-	5	2	4	5	4	4	2	4	4	-	3,78
	E4	Interessant om deze RIW (Regulatory Implementation Workflow) in een nieuwsartikel te delen van de brancheorganisaties om meer begrip, nut en noodzaak te creëren de sector in	Perceptie dat ervaring i.p.v. geschreven protocol ook voldoende kan werken	Voor E3: specifiek maken	Tijd	Geen bottleneck	Duidelijk beleggen van verantwoordelijkheden is essentieel	-	-	-	De bedrijfscultuur. De visserij is toch een vrij stugge en conservatieve wereld. Deze architectuur wordt al gauw gezien als te veel poespas wat afleid van de core business.	Duidelijke procesbeschrijving met uitleg en modellen.	-
Eindvragen	F1	4	4	4	3	3	4	3	-	4	4	5	3,80
	F2	4	5	4	5	4	4	4	-	4	4	5	4,30
	F3	Mooi in beeld gebracht	-	-	Vond het een zeer interessante	-	Nee	-	-	-	Als leek op dit vakgebied, kwam	-	-
		3,92	4,69	3,75	4,06	4,31	3,88	4,64	3,21	4,13	4,25	4,69	4,08

Figure L.1: Information Standards & Structures View

Appendix M

Industry Evaluation Questionnaire

Naam	
Functie	
Organisatie	
Datum	
Locatie	

Doel van het formulier

Dit formulier is bedoeld om feedback te verzamelen op de voorgestelde referentiearchitectuur voor de Nederlandse visserijsector. De feedback wordt gebruikt om te beoordelen in hoeverre de architectuur relevant, duidelijk, compleet en toepasbaar is binnen de sector, en om mogelijke verbeterpunten te identificeren.

Het formulier bestaat uit vragen over de volgende onderdelen:

1. Relevantie voor de sector
2. Architectuurprincipes en Good Practices
3. Viewpoints en Views
4. Samenhang en compleetheid
5. Begrippenlijst
6. Algemene beoordeling

1. Deel A – Relevantie & Waarde voor de sector

A.1 De referentie architectuur adresseert de belangrijkste uitdagingen rondom traceability en compliance in de visserijsector.

1	2	3	4	5
Helemaal niet				*Volledig*

A.2 De referentie architectuur lijkt toepasbaar voor een brede groep Nederlandse visserijbedrijven.

1	2	3	4	5
Helemaal niet				*Volledig*

A.3 De referentie architectuur biedt toegevoegde waarde boven bestaande werkwijzen in de sector.

1	2	3	4	5
Helemaal niet				*Volledig*

A.4 Wat ziet u als het meest waardevolle onderdeel van de referentiearchitectuur voor de sector?

2. Deel B – Architectuurprincipes & Good Practices

B.1 De principes zijn duidelijk geformuleerd en begrijpelijk.

1	2	3	4	5
Helemaal niet				*Volledig*

B.2 De good practices zijn relevant en bruikbaar voor organisaties in de visserijsector.

1	2	3	4	5
Helemaal niet				*Volledig*

B.3 De combinatie van toelichtend document en Excel-overzicht ondersteunt praktisch gebruik.

1	2	3	4	5
Helemaal niet				*Volledig*

B.4 Zijn er principes of good practices die u mist of anders zou willen zien?

3. Deel C – Viewpoints & Views

C.1 De gekozen viewpoints dekken de belangrijkste perspectieven rondom traceability.

1	2	3	4	5
Helemaal niet				*Volledig*

C.2 De views zijn begrijpelijk en helpen om overzicht te krijgen van processen, informatieobjecten, systemen, en verantwoordelijkheden.

1	2	3	4	5
Helemaal niet				*Volledig*

C.3 De views kunnen nuttig zijn als communicatiemiddel tussen stakeholders in de sector.

1	2	3	4	5
Helemaal niet				*Volledig*

C.4 Welke viewpoints of views zijn volgens u het meest waardevol of kunnen nog worden verbeterd?

4. Deel D – Samenhang & Compleetheid

D.1 De architectuurprincipes, viewpoints en views vormen samen een coherent geheel.

1	2	3	4	5
Helemaal niet				*Volledig*

D.2 Er ontbreken geen belangrijke concepten of elementen die essentieel zijn voor een referentie architectuur in de sector.

1	2	3	4	5
Helemaal niet				*Volledig*

D.3 Wat zou moeten worden toegevoegd of aangepast om het geheel completer of duidelijker te maken?

5. Deel E – Begrippenlijst

E.1 De begrippenlijst ondersteunt een eenduidig begrip van kernconcepten.

1	2	3	4	5
Helemaal niet				*Volledig*

E.2 De termen zijn herkenbaar en relevant voor de sectorpraktijk.

1	2	3	4	5
Helemaal niet				*Volledig*

E.3 Zijn er termen die u mist of anders gedefinieerd zouden willen zien?

6. Deel F – Algemene beoordeling

F.1 Hoe waarschijnlijk is het dat u deze referentiearchitectuur zou aanbevelen aan andere organisaties in de sector?

1	2	3	4	5
Zeer onwaarschijnlijk				*Zeer waarschijnlijk*

F.2 Wat is uw algemene oordeel over de referentiearchitectuur?

1	2	3	4	5
Zeer slecht				*Uitstekend*

F.3 Overige opmerkingen, zorgen of aanbevelingen?

Appendix N

Complete Industry Evaluation Results

		Visfederatie	PFA / RVZ	
Relevantie & Waarde	A1	4	5	4,50
	A2	4	4	4,00
	A3	3	5	4,00
	A4	Referentie architectuur geeft een goede overview van benodigde organen om goede bedrijfsvoering uit te oefenen	Een de facto beslisboom met relevante factoren voor een op handen zijnde wijziging van (uitvoerings)regelgeving.	-
Architectuurprincipes & Good Practices	B1	4	5	4,50
	B2	3	5	4,00
	B3	4	5	4,50
	B4	-	-	-
Viewpoints & Views	C1	4	5	4,50
	C2	3	5	4,00
	C3		4	4,00
	C4	Compliance & Sector Communication Viewpoint	Compliance meest waardevol, gezien grootste kans op 'inbreuken' op de bedrijfsvoering bij wijzigingen of onbedoelde overtreding van regelgeving.	-
Samenhang & Compleetheid	D1	4	5	4,50
	D2	3	5	4,00
	D3	-	-	-
Begrippenlijst	E1	4	5	4,50
	E2	4	4	4,00
	E3	Het is een goede basis. Mogelijk dat bij het verder integreren meer begrippen toegevoegd kunnen worden	Eventueel toevoegen LAN (vangstrapportage intern en aan Producentenorganisatie).	-
Algemene Beoordeling	F1	4	5	4,50
	F2	4	5	4,50
	F3	Erg mooie werkwijze om de samenhang en noodzaak duidelijk te maken. Goed om als basis mee te starten om een goed werkende organisatie te hebben	-	-
		3,71	4,80	4,27

Figure N.1: Information Standards & Structures View