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Integrate use of drones and qr codes as complementary components for monitoring, control and surveillance systems for artisanal fishing vessels in Peru

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INTEGRATED USE OF DRONES AND QR CODES AS COMPLIMENTARY COMPONENTS FOR MONITORING, CONTROL AND SURVEILLANCE SYSTEMS FOR ARTISANAL FISHING VESSELS IN PERU

By

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DECLARATION

I certify that all the material in this dissertation that is not my work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my personal views and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: Integrated use of drones and QR codes as complimentary components for monitoring, control and surveillance systems for artisanal fishing vessels in Peru.

Degree: **MSc**

This dissertation aims to design a new monitoring, control and surveillance (MCS) component that may be suitable for Peruvian artisanal fishing. When it refers to suitable, it means that it should be low-cost and compatible with other MCS systems to improve the fight against Illegal, Unreported and Unregulated (IUU) fishing.

In this regard, through the triangulation among methods including the content analysis as well as interviews and questionnaires to the primary stakeholders of the Peruvian artisanal fishing, it was found that there is a direct connection between a suitable MCS and the fulfilment of the target 14.b of the Sustainable Development Goal 14: provide artisanal fishers access to marine resources and markets. This connection is the key factor to aid to solve the two most important Peruvian artisanal fishing problems, immersed in a vicious circle that prevents their development: informality and low productivity of the value chain.

Thus, if the Peruvian artisanal fishing it is formalized, there is going to be a fewer risk to marine ecosystems, so, fishers would have more access to resources. Likewise, the value chain would be more productive, and the fishers would have more access to local and international markets and in turn more possibility to formalization. In this sense, the way to achieve such formalization is through a suitable MCS.

Finally, to find a suitable MCS, with the data gotten from triangulation and having employed a multi-criteria decision-making method to compare the most important trends in MCS, it is concluded that the integrated use of drones and Quick Response codes are the best solution possible to a suitable MCS. This new design was theoretically tested taking the results of a previous study from 2016. However, for their implementation, future research focusing on the application and experimentation of the new design is necessary.

Keywords: IUU fishing, Artisanal fishing, MCS, Drones, QR codes, SDG 14.b.

TABLE OF CONTENTS

DECLARATION ii
ACKNOWLEDGEMENTS iii
ABSTRACT iv
TABLE OF CONTENTS v
LIST OF TABLES vii
LIST OF FIGURES viii
LIST OF ABBREVIATIONS ix
1 INTRODUCTION 1
1.1 Background 1
1.2 Objectives 3
1.3 Scope and estructure of the dissertation 4
2 IUU FISHING 6
2.1 Generalities 6
2.1.1 Perspectives of IUU fishing 6
2.1.2 Defining IUU fishing 7
2.1.3 Methods in IUU fishing 10
2.1.4 Causes of IUU fishing 11
2.1.5 Main measures against IUU fishing 12
2.2 Monitoring, control and surveillance (MCS) 15
2.2.1 Definition of MCS 15
2.2.2 Components of MCS 16
2.2.3 Effectiveness in MCS 16
2.2.4 Trends in MCS 21
2.3 Artisanal fishing 22
2.3.1 Generalities 22
2.3.2 IUU fishing and MCS in artisanal fleet 23
2.3.3 New technologies for MCS for artisanal fishing 24
2.3.4 Traceability 28
3 PERUVIAN FISHING 31
3.1 Generalities 31
3.2 Measures against IUU fishing 32
3.3 Situation of artisanal fishing 32
3.3.1 High informality and IUU fishing 33
3.3.2 Monitoring, control and surveillance (MCS) of Peruvian artisanal fishing. 38

3.4 MCS for achievement of Sustainable Development Goal (SDG) 14, target 14.b in Peru 45
3.4.1 Generalities 45
3.4.2 Connection between MCS and target 14.b, SDG14, provide access to marine resources and markets 46
3.4.3 Indicators issues 46
4 RESEARCH METHODOLOGY AND DATA ANALYSIS 48
4.1 Research Methodology 48
4.1.1 Qualitative content analysis 49
4.1.2 Interview questions 49
4.1.3 Questionnaires 53
4.2 Data analysis 55
4.2.1 Qualitative content analysis results 55
4.2.2 Interviews results 61
4.2.3 Findings from questionnaires 67
4.3 Triangulation among methods 77
5 NEW MCS DESIGN SUITABLE FOR ARTISANAL FISHING IN PERU 82
5.1 Making decisions about deisgn alternatives 82
5.2 The new design 85
5.3 Discussion 85
6 CONCLUSIONS 90
REFERENCES 92
APPENDICES 105

LIST OF TABLES

Table 1. Fao Ocean areas-highest risk of stocks for IUU fishing 9
Table 2. Effectiveness of different MCS components 17
Table 3. Advantages and disadvantages of different components of MCS..... 18
Table 4. Indicators for Strategic actions in the Multiannual Sectorial Strategic Plan of PRODUCE 47
Table 5. Number of inspectors for each head of the region 51
Table 6. Approximate number of associates of each artisanal fishing trade unions in the study 52
Table 7. IUU fishing roots and consequences..... 55
Table 8. Common features of IUU fishing..... 56
Table 9. MCS approaches of FAO for artisanal fisheries 56
Table 10. Measures that can stop IUU fishing 57
Table 11. New trends in MCS technology for artisanal fisheries..... 58
Table 12. Practical examples of uses of technology for MCS in artisanal fishing..... 59
Table 13. The connection between IUU fishing and other criminal activities 60
Table 14. Main aspects of IUU fishing in Peruvian artisanal fleet. 60
Table 15. The connection between target 14.b of SDG 14 and IUU fishing 61
Table 16. Results of the decision-making matrix..... 83
Table 17. Theoretical effectiveness test for drones and QR codes..... 89

LIST OF FIGURES

Figure 1. Perspectives of IUU fishing 7
Figure 2. Common forms of IUU fishing. 9
Figure 3. Entry of illegal fish into the supply chain 11
Figure 4. International Organizations involved in IUU fishing and related fish crimes issues ... 13
Figure 5. Camera installed onboard artisanal fishing vessel in Peru. 26
Figure 6. Variables that affect operational and tactical UAV employment. 27
Figure 7. A hand-line fishing vessel with a sticker with a QR code tag in Indonesia. 29
Figure 8. A tuna fish with RFID tag on board a fishing vessel in Oceania for traceability "from the vessel to the supermarket". 30
Figure 9. Classification of Peruvian marine commercial fishing. 31
Figure 10. Amount of fishing vessels with and without Fishing License (FL), by region. 33
Figure 11. Amount of fishing vessels with and without the Vessel Registration Certificate (VRC), by region. 35
Figure 12. Vicious circle in the value chain in the Peruvian artisanal fishing activity. 36
Figure 13. Reasons that explain fishing vessels not register in the National Public Record. 37
Figure 14. Vessels within the area of application of SISESAT. 40
Figure 15. Complementation of areas of application between SISESAT and SIMTRAC. 41
Figure 16. Integrated subsystems of the SIMTRAC of DICAPI. 42
Figure 17. Flow of the main processes in the artisanal fishing traceability. 45
Figure 18. Map with the location of the interviewees and people who answered the questionnairies. 54
Figure 19. Most frequent mean used by DICAPI to monitor artisanal fishing vessels. 68
Figure 20. Most efficient mean used by DICAPI to monitor artisanal fishing vessels. 68
Figure 21. Most important deficiency that reduce the efficiency of DICAPI to inspect artisanal vessels 69
Figure 22. Best place to inspect efficiently the artisanal fishing vessels. 70
Figure 23. Level of importance for DICAPI about having digital information for artisanal fishing vessels. 70
Figure 24. Level of importance for DICAPI about having automated control procedures for artisanal fishing vessels. 71
Figure 25. The main reason why DICAPI does not have digital information about artisanal fishing vessels nor automated control procedures for them 72
Figure 26. The best way for DICAPI to improve efficiency over the control of artisanal fishing vessels. 73
Figure 27. Types of navigation information record for artisanal fishing vessels, of DICAPI. ... 74
Figure 28. Level of importance for DICAPI about having the register of navigation information. 74
Figure 29. Level of engagement of artisanal fishing vessels in illegal activities apart of IUU fishing. 75
Figure 30. Types of illegal activities that artisanal fishing vessels could be involved. 76
Figure 31. Opinion about the inclusion of artisanal fishing vessels into SIMTRAC domain 76
Figure 32. Conceptual map of the summary of the findings of triangulation among methods ... 81

LIST OF ABBREVIATIONS

AIS	Automatic Identification System
CDS	Catch Documentation Schemes
CEPLAN	National Strategic Planning Centre

CLS	Collecte Localization Satellites
COFI	Committee on Fisheries
COO	Certificate of Origin
DICAPI	General Directorate of Captaincies and Coast Guard of the Peruvian Navy
EEZ	Economic Exclusive Zones
EMS	Electronic Monitoring Systems
EMSA	European Maritime Safety Agency
ERS	Electronic recording and reposting systems
EU	European Union
FAO	Food and Agriculture Organization
FL	Fishing License
FLUX TL	Flux Transportation Layer
GMS	Global System for Mobile Communications
GPS	Global Positioning System
GPRS	General Packet Radio Service
ICCAT	International Commision for the Conservation of Atlantic Tunas
ICT	Information and Communications Technology
IPOA	International Plan of Action to prevent, deter and eliminate Illegal, Unreported and Unregulated Fishing

ISSF	International Seafood Sustainability Foundation
IUU	Illegal, Unreported and Unregulated
I-VMS	Inshore Vessel Monitoring Systems
MCDM	Multi-criteria decision-making
MCS	Monitoring, Control and Surveillance
MMO	United Kingdom Marine Management Organisation
MPA	Marine Protected Areas
NOAA	National Oceanic and Atmospheric Administration
OECD	Organization for Economic Cooperation and Development
OSPA	Artisanal Fishing Unions
PRODUCE	Ministry of Production of Peru
PSMA	FAO Agreement on Port State Measures to Prevent, Deter and Eliminate, Illegal, Unreported and Unregulated Fishing
PVR	Proactive Vessel Registration
QR	Quick response
RFID	Radio Frequency Identification
RFMO	Regional Fisheries Management Organizations PNP Perivian National Police
RMRR	Raw Material Reception Record
SASSI	South African Sustainable Seafood Initiative
SC	Sourcing Certificates

SCC	Simplified Catch Certificate
SDG	Sustainable Development Goals
SIFORPA	System of Artisanal Fishing Formalisation
SIMTRAC	Aquatic Traffic Information and Monitoring System
SMART	Specific, measurable, achievable, relevant and time-oriented
SISESAT	Satellite Tracking System
SP	Sanitary Protocol of the Vessel
TCP/IP	Transmission Control Protocol/Internet Protocol
UAV	Unmanned Aerial Vehicles
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
VDS	Vessel Detection Systems
VG-CDS	Voluntary Guidelines on Catch Documentation Schemes
VG-FSP	Voluntary Guidelines for Flag State Performance
VHF	Very High Radiofrequency
VMS	Vessel Monitoring System
VRC	Vessel Registration Certificates
VTS	Vessel Tracking System
VTS	Vessel Traffic Services

WTO	Wrold Trade Organization
WWF	World Wildlife Fund

1 INTRODUCTION

1.1 Background

Fisheries provide more than 110 million tons of food and around 15% of the dietary protein for the more than 7 billion people currently living on the earth (Frid & Paramor, 2012). In 2014, "…this activity produced, approximately, 167 millions of tons of fish and made over US$ 148 billions in exports, securing access to nutrition for billions of people and accounting for 17 percent of total global animal protein, even more in poor countries" (Oceans, Fisheries and Coastal, 2018). Also, the Food and Agriculture Organization (FAO) recognizes the importance of fish and their associated products "for food security and nutrition; economic growth through fish production and; poverty alleviation and the creation of employment opportunities in rural areas" (FAOs role in fisheries, n.d.).

However, overfishing almost compromises 90% of the global stocks, and production will increase further by 2025 (Global fish production, 2016). In this respect, illegal fishing is a crucial driver of this global problem since "it menaces marine ecosystems, puts food security and regional stability at risk and is linked to major human rights violations and even organized crime" (Illegal fishing, n.d.).

According to a study by the European Parliament, the global losses per year related to IUU fishing are between USD 10 billion to USD 23.5 billion, with developing countries being the ones most at risk (Illegal, unreported and unregulated, 2014). The most common forms of IUU fishing include "fishing without a license, exceeding quotas, targeting under-sized fish or endangered species, using banned fishing gear, fishing in restricted or closed areas, repackaging illegal catch into containers labeled with the name of a legal vessel, and transshipping" (Cutlip, 2016).

On the other hand, as the World Bank claims, in fact, poor fisheries poor management squanders roughly US$80 billion annually in lost economic potential and 11% in catch potential (Oceans, Fisheries and Coastal, 2018).

For the specific area of the present study, Peru, IUU fishing is carried out by national and foreign flag vessels and, according to José Graziano da Silva, General Director of FAO, "it has an economic impact of over US$ 360 million annually" (Fin a los piratas, 2016).

Likewiese, the most common IUU fishing forms include the fishing ina Marine Protected Areas (MPA) and the invasion of the five miles exclusive for artisanal fishing by large-scale vessels or vessels that practice trawling. Further forms include the lack of respect for temporary closures of fishing seasons, the not reported discards and the fishing of young species over legal limits (Pesca ilegal, n.d.).

This situation occurs due to poor fisheries management even though Peru has one of the most productive marine ecosystems in the world, in which catches represent almost 10% of the global fisheries (Luna, 2017). Besides, "in Peru, 300 thousand people are engaged in the fishing activity and from it depend on their means of subsistence" (Chiang, 2018).

Nonetheless, in a country where chronic malnutrition still affects 12.9% of children younger than five years old (INEI: desnutrición infantil, 2018) and where specialists have demonstrated that fish consumption is a natural and effective way to fight against malnutrition (MINSA, consumir pescado, 2011), having poor fishing management is not acceptable in Peru.

For instance, Peru has the most substantial single-species fishery in the world, the anchovy fishery. This fishery, which in 2015 produced 852 million tons of fish oil, becoming the dominant globally producer of this product for industrial purposes instead human consumption, made it mainly by large-scale fishery (Pesca: retos para, 2017). This kind of fishing is usually a formal economic activity that is relatively controlled by the government. Nevertheless, the Fishing Management Regulations applied in the last years have not been able to stop the excessive growth of the anchovy fleet nor the processing plants of fish meal and oil. Also, only 5% of the annual permitted fishing quota, which is generally between 6 and 7 million tons, is used for direct human consumption even though the anchovy has one of the meats with the highest protein and unsaturated fatty acids content (López-Trelles, 2015).

On the other hand, the artisanal fishery in Peru, which is the focus of this dissertation, is dedicated mainly to direct human consumption. It has a millennial tradition inherited from the pre-Incas civilizations and the Inca Empire (Rostworowski, 2016). However, this type of fishing is very informal and the different governments, traditionally, have abandoned it for almost 200 years of republican history.

A clear example of this is the fact that just in 2012, the first statistical study was carried out on this type of economic activity (Medicina, 2014). It showed that almost 40% of artisanal fishing vessels had been working without licenses or permits from the authorities, which has negative consequences on the quality of life of artisanal fishers. It is important to remember that in Peru, artisanal and small-scale fishery is usually associated with lack of education and poverty (Medicina, 2014). Regarding education, only 32% of the artisanal fishers have primary studies while only 58% have high school studies (Galarza & Kamiche, 2015). Likewise, in the case of poverty, the two majors socioeconomic problems for artisanal fishers are the Unsatisfied Basic Necessities: Quality of Housing (15.86%) and Economic Capacity (16.34%) due to the low possibility of income generation in these households (Galarza & Kamiche, 2015).

In this sense, it is possible to claim that the leading causes of the artisanal fishery problems are the high informality (Medicina, 2014), the low productivity of the value chain: from extraction, through processing and trade to final consumption (Galarza & Kamiche, 2015) as well as the low capacity of MCS applicable to this kind of fishery. These factors finally foster IUU fishing and prevent artisnal fishers to get access to marine resources and markets.

The present work analyzes the different aspects of IUU fishing and the various measures to combat it. It searches for a new design for a MCS system that may be suitable for artisanal fisheries in Peru, through the use of modern up-to-date information and communication technologies (ICT) in a novel and integrated manner. Moreover, it assesses the connection between MCS and access of artisanal fishers to marine resources and markets, in relation to target 14.b of the Sustainable Development Goal N°14 (SDG 14).

1.2 Objectives

The present dissertation aims, in a general sense, to design a new MCS component that may be suitable for Peruvian artisanal fishing. Specifically, it aims to assess the deployment of drones and QR codes in an integrative and holistic way, as a new MCS measure for artisanal fishing vessels. Moreover, this new design should focus on reducing

IUU fishing and providing access to marine resources and market to artisanal fishers (SDG 14, target 14.b).

For that purpose, the research has the following sub-objectives:

- To understand the issues pertaining to IUU fishing world wide and in Peru.
- To analize the current MCS systems and measures, in the world and in Peru, for artisanal fishing vessels and their products.
- To assess how the newest trends in technology improve the efficiency of the application of MCS measures for artisanal fishing in an innovative way while keeping the cost at a minimun level.
- To demonstrate that the combination of drones and QR codes could improve the detection of IUU fishing from artisanal fishing vessels and provide access to marine resources and market to artisanal fishers.
- To develop a new enforcement procedure through drones and QR codes to improve the traditional MCS tools.
- To develop adequate indicators to measure the performance of the new design of MCS regarding the reduction of IUU fishing and provision of access to marine resources and market to artisanal fishers.
- To demonstrate how these technologies could improve the security and safety issues regarding informal small vessels.

1.3 Scope and estructure of the dissertation

The final results of the dissertation will focus on demonstrating the viability of the use of drones combined with QR codes to improve MSC measures related to the artisanal fishing fleet in Peru. It will also focus will be on how these kind of technologies could reduce IUU fishing and provide access to marine resources and market to Peruvian artisanal fishers.

For that reason, the study was divided into six Chapters.
Chapter 1 will introduce the background, objectives as well as the scope and estructure of the dissertation.

Chapter 2, will review the general aspects of IUU fishing worldwide for a better understanding of the drivers and causes, definitions, current situations and consequences of this illegal activity, with special emphasis on artisanal fishing. Additionally, it will cover the main international measures to combat IUU fishing which will include the main trends in MCS, also focused on artisanal fishing.
Chapter 3 will provide different aspects of Peruvian artisanal fishing, specifically, in relation to IUU fishing, the MCS measures and the fulfill of the SDG 14, target 14.b about providing access to marine resources and markets to artisanal fishers.

Chapter 4, will cover the research methodology and data analysis. Qualitative and quantitative methods to obtain the data will be explained and executed, and partial results will be shown. After that, the partial data analysis will be done through the triangulation methodologic procedure. This analysis will serve to explain all the obtained data to support the design of new MCS component.

Chapter 5, will explain the new MCS designed. To decide on the solution, the multi-criteria decision-making method will be employed. Then, the results will be discussed in reference to interpretation, implications and limitations of the designed solution.

Finally, in Chapter 6, the final conclusion of the dissertation will be shown, as well as recommendations for future studies.

2 IUU FISHING

2.1 Generalities

The impact of bad fishing practices began to worry the international community in the early 1990s when overfishing of cod in Canada brought negative consequences in that fishery. “More than 35,000 fishers and plant workers from more than 400 coastal communities lost their jobs” (Overfishing, illegal and destructive fishing, n.d.). While it is true that this type of bad practices was noted perhaps twenty years earlier in some other countries[1], the almost nonexistent environmental awareness, the lack of research capacity and the local rather than global vision during those years did not allow the real damages in fishing for the future generations to be perceived.

However, in February 1999, the FAO Committee on Fisheries (COFI), in its Twenty-Third Session, highlighted the importance of preventing, detering and eliminating IUU fishing (International Plan of Action, 2001).

2.1.1 Perspectives of IUU fishing

As we can see in the Canadian case, during those first years, there was just one way to understand the problem, and it was from a socioeconomic perspective. An ecological view was not involved. It is only in recent years, that this situation has changed. Today, it is a common understanding that IUU fishing has environmental impacts. Currently, FAO recognizes that IUU fishing is one of the greatest threats to marine ecosystems due to undermining the efforts to manage fisheries sustainably, as well as, the conservation of marine biodiversity (Illegal, unreported and unregulated fishing, 2016).

In the same way, the Organization for Economic Cooperation and Development (OECD) established two perspectives to understand IUU´s importance: ecological and economic. “From an ecological perspective, they identify long-term obstacle to sustainable fisheries that affect species and the ecosystems which maintenance healthy fisheries. From an

[1] In Peru, between 1960 and 1970, the boom of the anchoveta fishery for its transformation into fishmeal condemned it almost to its extermination, due to the practice of irresponsible capture (Medicina, 2014)

economic perspective, it causes important losses. Also, it is a low risk, profitable economic activity" (Fishing for development, 2014a).

Furthermore, the International MCS Network, identified IUU fishing problems as follows:

> In short-term IUU fishing causes the unsustainable harvest of fish stocks and other marine wildlife, destruction of marine habitats, a loss for future harvest, loss of nutrition, and loss of income and employment for legitimate fishers.
>
> In long-term, IUU fishing can diminish or extinct local, and potentially global fish stocks. It also can undermine labor standards, alter markets of legally harvested fish and contribute to the loss of economic stability in developing coastal nations (What is IUU fishing? N.d.).

Figure 1 shows the three main perspectives of IUU fishing.

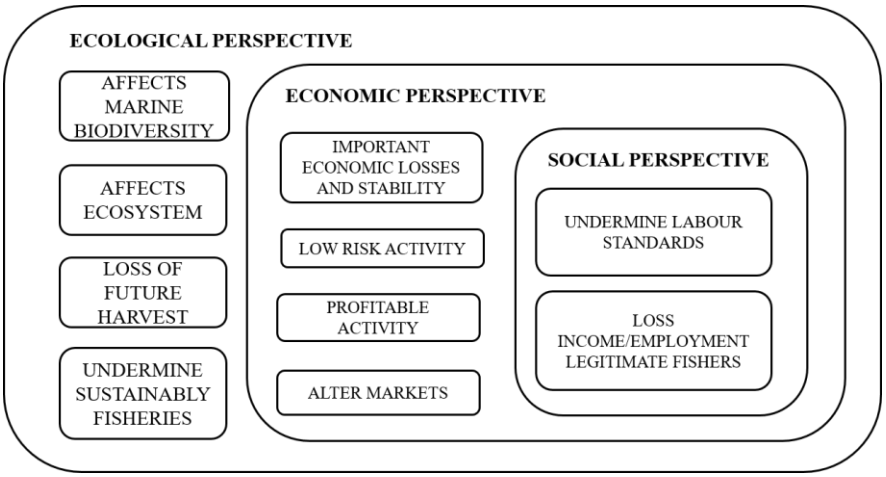

Figure 1. Perspectives of IUU fishing
Source: Own elaboration (2018)

2.1.2 Defining IUU fishing

For a real understanding of the IUU fishing, it is necessary to define it. A simple definition of IUU fishing by the International Monitor, Control and Surveillance Network (International MCS Network) is: "the fishing that is conducted contradictory to legal

conservation and current management measures in place around the world" (What is IUU fishing? n.d.).

Moreover, FAO (Illegal, unreported and unregulated fishing, 2016) define IUU fishing as a broad term which includes:

- Fishing and fishing-related activities conducted in contravention of national, regional and international laws;
- Non-reporting, misreporting or under-reporting of information on fishing operations and their catches;
- Fishing by "Stateless" vessels; fishing in convention areas of Regional Fisheries Management Organizations (RFMOs[2]) by non-party vessel;
- Fishing activities which are not regulated by States and cannot be easily monitored and accounted.

As we can see, the term IUU fishing is currently widely used. Nonetheless, in all cases, it covers many types of fishing operations: large-scale fishing, small-scale fishing, and subsistence fishing (Fishing for development, 2014b). Also, it covers fishing that is running inside or outside of areas of national jurisdiction (Combating IUU fishing, 2004). In this sense, while it is true that the "Economic Exclusive Zones (EEZ) cover only 35% of the total ocean extent, it contains almost 90% of worldwide fish stocks. Therefore IUU fishing actions in the EEZ have direct harmful effects on the domestic economies" (Illegal, Unreported and Unregulated Fishing, 2016). Figure 2 shows the most commons forms of IUU fishing.

[2] RFMOs are international organizations formed by countries with fishing interests in an area, some of them manage all the fish stocks found in a specific area while ohers focus on particular highly-migratory species. Some RMFOs have a purely advisory role but motst of them have management powers to set catch and fishing effort limits, technical measures and control obligations (Regional fisheries management, n.d.).

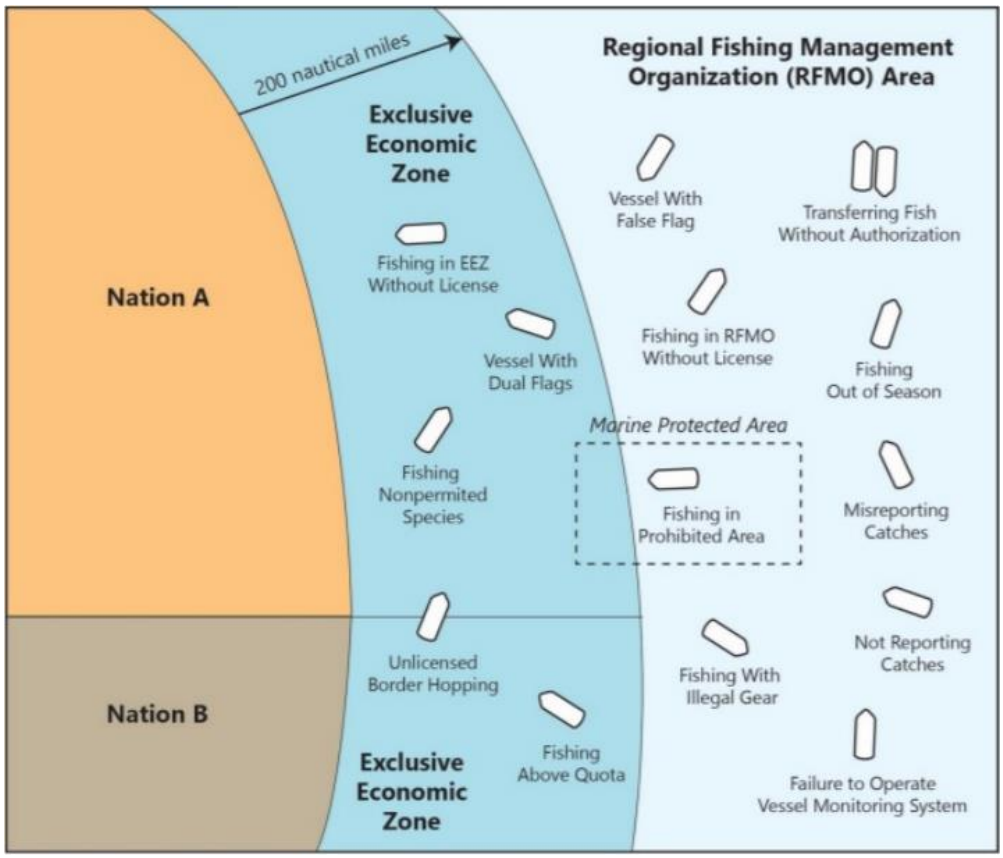

Figure 2. Common forms of IUU fishing.
Source: Reprinted from Illegal, Unreported and Unregulated fishing (2017)

Although some countries are more affected than others by IUU fishing and some countries have more fleet involved in IUU fishing than others, the issue is that according to an analysis of World Wildlife Fund (WWF) in 2015, more than 85% of worldwide fish stocks are at high or moderate risk of IUU fishing (Illegal fishing, 2015). Table 1 shows the FAO Ocean Areas with the highest risk of stocks for IUU fishing.

Table 1. Fao Ocean areas-highest risk of stocks for IUU fishing

Ocean Basin (FAO Area)	High Risk	Moderate Risk	% of Global Catch by Volume (excluding tunas)
Western Central Pacific (FAO Area 71)	90%	10%	12%
Southeast Pacific (FAO Area 87)	90%	10%	14%
Eastern Indian Ocean (FAO Area 57)	88%	12%	8%
Northwest Pacific (FAO Area 61)	87%	13%	24%
Southwest Atlantic (FAO Area 41)	87%	13%	2%
Western Indian Ocean (FAO Area 51)	87%	--	4%
Eastern Central Atlantic (FAO Area 34)	79%	21%	3%
Western Central Atlantic (FAO Area 31)	68%	16%	1%
Eastern Central Pacific (FAO Area 77)	67%	24%	2%
Mediterranean and Black Sea (FAO Area 37)	66%	34%	2%

Note: Data from Illegal Fishing by World Wildlife Fund (2015).

In this sense, for the particular case of the area of the present study, Peru, the Southeast Pacific – FAO Area 87[3], 90% of the fish stocks assessed by FAO were categorized as being at a high level of risk of IUU fishing. Of those, according to assessments three stocks are overexploited, seven stocks are fully exploited, seven stocks have an unknown status and one stock was assessed as non-fully exploited/overexploited. Also, specialist categorized two stocks (10%) at moderate levels of IUU fishing (Illegal fishing, 2015). Further, in this area, the species Inca scad (Chilean jack mackerel) had a stock status of overexploited (Illegal fishing, 2015).

On the other hand, according to the National Oceanic and Atmospheric Administration of the United States (NOAA), some examples of IUU fishing may include (Illegal, Unreported, and Unregulated Fishing, 2017):

- Fishing without a license or quota for some species;
- No reporting catches or making false reports;
- Fishing undersized fish or fish that are protected by regulations;
- Fishing in closed areas or during closed seasons and using prohibited fishing gear; and
- Making unauthorized transshipments to cargo vessels.

2.1.3 Methods in IUU fishing

Phelps (2015) explains the main methods of IUU fishing. The most important ones involve Fish Laundering, Transshipment, and Ports of Convenience.

In this regarding, in the transshipment or transfer of fish at sea, illegal fishers combine legal and illegal fish, so they create fish laundering. Usually, a reefer collecter vessel collects the fish from various individual fishing vessels that are often exempt from documentation and monitoring. Then, these re-supply vessels take advantage of ports of convenience, which are ports that have minimum or no inspection activities. In any case,

[3] This area includes the EEZ of Ecuador, Peru and Chile and part of the EEZ of Colombia. About 14% of the worldwide catch is from this region, excluding tuna catches (Illegal fishing, 2015).

IUU activities can happen at all stages of the fisheries value chain (Phelps, 2015). Figure 3 shows how illegal fish enter into the supply chain.

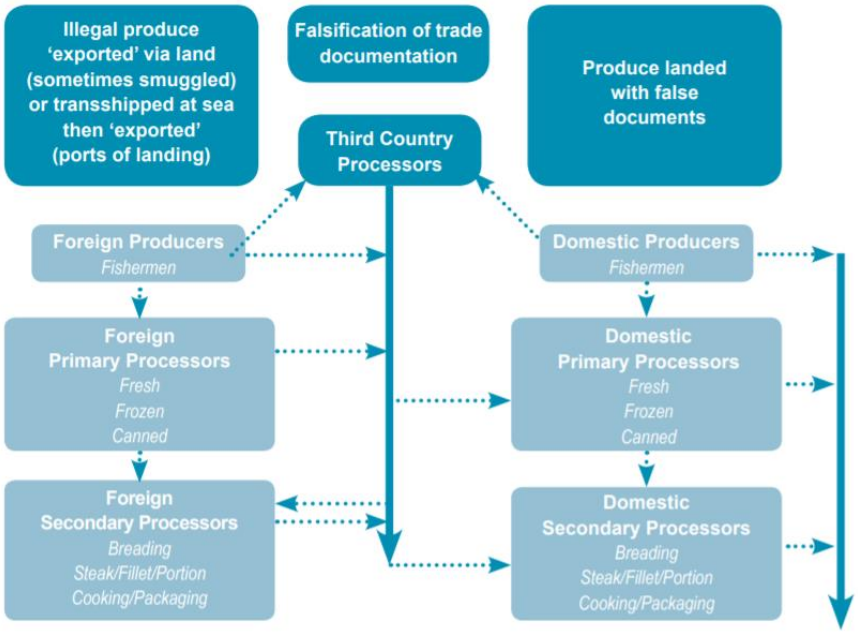

Figure 3. Entry of illegal fish into the supply chain
Source:.The Seafish Guide (2012)

2.1.4 Causes of IUU fishing

According to a Britsh non – departmental public body, Seafish, the clear driver for IUU fishing is economic benefit. "The vessels involved in this activity minimize operational costs, including costs of licensing, regulation and, use of monitoring systems. Besides, this type of activity can occur due to poor governance and shortcomings in national and international controls" (The Seafish Guide, 2012).

In this respect, the Sub-Regional Fisheries Commission, an intergovernmental West African fisheries cooperation organization, integrated by Cabo Verde, The Gambia, Guinea, Guinea-Bissau, Mauritania, Senegal, and Sierra Leone worked to identify the leading causes of IUU fishing, and the following were indetified (The future of Fish, 2013):

- The insufficient and inadequately trained personnel in the relevant authorities;
- The lack of motivation to invest in personnel due to other financial priorities of the states;
- Low salaries of the authorities allowing vessel owners to take advantage of making irregular payments to them to cover up their activities (corruption);
- The lack of logistics and spending capacity to purchase, maintenain and operate patrol vessels and aircraft.

Likewise, IUU fishing involves varied actors, including organized crime groups, big commercial fishing enterprises, and corrupt officers. Furthermore, IUU fishing is overlapped with other types of organized maritime crime, including drug smuggling, trafficking in persons for forced labor on fishing boats and piracy (Liddick, 2014).

In that sense, a study from 2017 (Illegal, Unreported and Unregulated fishing, 2017) affirms that IUU fishing supports illicit networks of actors involved in organized crime including piracy, armed insurgency, and terrorism. Moreover, such study mentions that the regional task force, FISH- I Africa, established in 2012, claimed the fisheries crime works in combination with other crimes like tax evasion, drugs, diamonds, arms, wildlife, and human rights abuse, including human trafficking.

2.1.5 Main measures against IUU fishing

Addressing ways to fight against IUU fishing, Jenning (2014) presents five main ways to do it:

- The legislation, through the development of an international and national coordinated legal framework for addressing IUU fishing on a global scale;
- Global Vessel Identification, to reduce the ability of vessels to hide behind new identity or flag of convenience;
- Seafood Traceability, to prevent that the product being bought and sold illegally;
- Monitoring, Surveillance, and Compliance, for effective enforcement of legislation and regulations and;

- Development that refers to multisectoral cooperation to develop alternative sources of employment instead of IUU fishing.

In this respect, an international framework has been established and led by many international organizations to address fisheries management and to combat IUU fishing. Figure 4 shows the leading international organizations involved.

Figure 4. International Organizations involved in IUU fishing and related fish crimes issues.
Source: An inventory of new technologies (2017)

Some of the main legal frameworks are (Illegal, unreported and unregulated fishing, 2016):

- The United Nations Convention on the Law of the Sea, UNCLOS (1982),
- FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (1993),
- UN Fish Stocks Agreement, UNFSA (1995),
- FAO Code of Conduct for Responsible Fisheries (1995),
- International Plan of Action to prevent, deter and eliminate Illegal, Unreported and Unregulated Fishing, IPOA – IUU (2001),

- FAO Agreement on Port State Measures to Prevent, Deter and Eliminate, Illegal, Unreported and Unregulated Fishing, PSMA (2009),
- Voluntary Guidelines for Flag State Performance, VG - FSP (2014) and
- Voluntary Guidelines on Catch Documentation Schemes, VG-CDS (2017).

Neverthless, the principal instrument to address this problem may be the International Plan of Action to prevent, deter and eliminate IUU Fishing. It "includes trade restrictions, port enforcement actions, catch documentation schemes (CDS), vessel registration and licensing systems, maintenance records of fishing vessels, and the implementation of MCS measures" (Liddick, 2014).

Finally, the international community has been applying some strategies to minimize IUU fishing. The most important are (Baird, 2004):

- Port and Market State Controls: the Port States require that vessels submit the specific documentation including the details and nature of the fishing vessels, crew members, fish on board and fishing license. For the market, controls are similar to the Port Controls but regulate the import and export of fish products. States could restrict the movement of products that are involved in IUU (Baird, 2004).
- The IUU Vessel Database: works as a "blacklist" that includes vessels involved in IUU activities. In the case of the European IUU vessel list, if there is a suspicious vessel, the EU alerts the flag State. If the flag State fails to take measures, the vessel is placed in that list and implies restrictive measures (Illegal, unreported and unregulated fishing, 2014).
- Cooperative Surveillance and Enforcement: Based in International Law, this measure can go from data exchange and observers, boarding and referral to the flag State and boarding and arrest by a third State (Kaye, 2014). It can also include assistance among States with vessels engaged in "hot pursuit[4]" (Baird, 2014). The nature of IUU fishing in the large EEZs of countries without enforcement and surveillance capability and the development of these activities in zones near the borders of neighboring countries emphasizes the need for this

[4] Article 111° of the UNCLOS in which it recognizes the right of a State to pursue a vessel belonging to a foreign State which has violated any law within its territorial boundaries and jurisdiction (Bhattacharya & Prabhat, 2016).

cooperation. Examples of this are the bilateral negotiations between Australia and South Africa, and the Niue Treaty[5].

2.2 Monitoring, control and surveillance (MCS)

In response to the problem of international IUU fishing, an important initiative of the world fisheries administrations has been the improvement of MCS measures (Fishing problems: Pirate fishing, n.d.).

2.2.1 Definition of MCS

According to FAO, the design of MCS should ensure compliance with fishery management measures and its main objective is to aid in the achievement of good fishery management by ensuring that the necessary information is available to establish appropriate controls (A Fishery Manager´s Guidebook, 2009). FAO defines each part of MCS as follows (A Fishery Manager´s Guidebook, 2009):

- Monitoring: Refers to the collection, measurement and analysis of fishing activities including, but not limited to, catch, species composition, fishing effort, bycatch, discards, and area of operations.
- Control: Involves the specification of the terms and conditions of the harvesting of the resources.
- Surveillance: Involves the regulation and supervision of fishing activity to ensure the observation of national legislation and terms, conditions of access and management measures.

[5] Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region.

2.2.2 Components of MCS

Peter Graham, an MCS Policy Advisor of the Pacific Islands Forum Fisheries Agency, established ten essential MCS components, for the case of Tuna, but for this study, applicable to any fisheries (Monitoring, Control, and Surveillance, 2016):

- Licensing;
- Vessel Monitoring System (VMS);
- Observer Schemes;
- Vessel Records and Authorisations to Fish;
- Port Control and Monitoring;
- Prosecutions;
- Boarding and Inspection and At Sea Patrols;
- Data Management and MCS Coordination;
- Aerial Surveillance; and
- Legislation, Regulations and Management Plans.

2.2.3 Effectiveness in MCS

Accordingly, FAO prepared a guide in which the effectiveness of different MCS components was analyzed (Table 2) (A fishery manager´s guidebook, 2009). FAO also prepared information about the advantages and disadvantages of such components (Table 3).

Table 2. Effectiveness of different MCS components

Dimension	Component	Effectiveness of element for management controls			Detection of unlicensed vessels/fishers	Ability to arrest	Cost
		Input	Output	Technical			
Before fishing	Clearance/issue of documentation	Medium	None	None	No	Yes	Low
	Vessel clearance	Medium	None	Low	No	Yes	Low
While fishing	Logbooks	Medium	Medium	Low	No	No	Low
	Patrol vessels	Medium	Medium	Medium	Medium	Yes	High
	Patrol planes	None	None	High	High	No	Medium
	Helicopters	None	None	High	High	Yes	High
	Observers	High	High	Medium	Low	No	Low/medium
	VMS	Medium	None	High	No	No	Low/medium
	Satellite imagery	None	None	Medium	Medium	No	Low/medium
	Beach patrols	High	High	High	High	Yes	Low
	Navy or coastguard	Low	Low	Low	High	Yes	High
During landing	Catch monitoring	None	High	None	No	Yes	Low
	Transhipment monitoring	None	High	None	No	Yes	Low
Post landing	Market and sales monitoring	None	Medium	None	No	Yes	Low
	Export monitoring	None	Medium	None	No	Yes	Low
	Roadblocks and transport monitoring	None	Low	None	No	Yes	Low

Note: Data from A Fishery Manager´s Guidebook. FAO and Wiley – Blackwell (2009).

Table 3. Advantages and disadvantages of different components of MCS

Component	Advantages	Disadvantages
Clearance/issue of documentation	Ensures valid documentation among the fishers and provides opportunity for briefing of captains.	Can only be performed on vessels calling at national ports with an MCS presence.
Vessel clearance	Good source for information about the fishery. Controls in relation to (e.g. engine size, fishing gear) can be conducted.	Fishing gear and other equipment may be hidden.
Logbooks	Can be used onboard any fishing vessel in any language. Keeps historical track on catches and positions. Cheap.	Poor literacy rate by fishers may be an obstacle in certain fisheries. Quality of data will depend on fishers´ motivation.
Patrol vessels	Provides at-sea verification of fishing gear, discards, dumping, logbooks and catches. Most important to control offshore operations and foreign fleets. The only platform that can effectively conduct an arrest offshore. High deterrence factor.	High-cost and limited area surveillance capability. Low rate of detection of infringements.
Patrol planes	Can provide high coverage for identification of illegal incursion of unlicensed vessels and effectively patrol borders and closed areas.	No ability to arrest or to inspect catch or gear.
Helicopters	Can cover relatively large area, can deploy inspectors on vessels and arrest.	High cost and limited distance covered compared to patrol plane.
Observers	Can monitor all operations onboard a specific vessel and verify catches, discard, dumping, gear and validation of required documents.	Medium cost. Only viable on larger vessels. The integrity of observers may be a relevant question in terms of the quality of data provided.
VMS	Provides up to real time monitoring for licensed or fitted vessels and can reduce interception times for enforcement craft. Low to medium capital and running costs.	No coverage of vessels not fitted with the required equipment. Require integration with other platforms or sensors to be utilized effectively. Technical maintenance and IT support can be limited in some countries.
Satellite imagery	Full coverage of area scanned.	Expensive for regular scans. No positive identification of targets unless verified by other sensors.
Beach patrols	Efficient tool within recreational and near-shore fisheries. Contact with fishers.	Visibility of inspectors, access to remote areas can be difficult.
Navy and coastguard	If available can be free to fisheries organization, if they are in the field they can monitor border violations.	Limited capability – only border violations as limited fishery knowledge.
Catch and transhipment monitoring	Can monitor landed catch and quotas. Has power to arrest in port. Low capital and running costs.	No possibility of monitoring vessels that do not call at port. No possibility of monitoring dumping, gear violations or offshore transhipments. Information is only of fish landed not those discarded and no geo-referenced data.
Market and sales monitoring	Good information source in terms of landed species and market demands.	Difficult to trace the origin of the fish.
Export monitoring	Good information source on volume of landed fish in high value fisheries.	Only part of the landed catch may be exported.
Roadblocks and transport monitoring	Good tool against sale and transport of illegally caught fish.	Roadblocks are easily detected and can be avoided.

Note: Data from A Fishery Manager´s Guidebook. FAO and Wiley–Blackwell (2009).

The problem with this guide is that was made in 2009. Currently, there are another MCS components based in technology that have not been assessed yet.

In the same way, a group of African researches (Doumbouya, Camara, Mamie, Intchama, Jarra, Ceesay, Gueye, Ndiaye, Beibou, Padilla & Belhabib, 2017) assessed the effectiveness of MCS in six countries of West Africa: Mauritania, Senegal, The Gambia, Guinea-Bissau, Guinea, and Sierra Leone. It is important to note that according to some experts, West Africa is one of the regions most affected by IUU fishing in the world. In this situation, the low chance of detection of this illegal activity has stimulated a prosperous market in illegal fishery products in which at least one out of every four fish caught in Africa is caught illegally (The Pan-African Fisheries, 2016).

The assessment considered different data, including:

- Amounts of fines;
- Number of detected offenders:
- Categories of offenses that are effectively fined;
- The illegal catch value; and
- The transparency of the information system.

As a result, the most important analysis of the study shows that independent of the efforts of some countries to improve the MCS legislation, the highest scored countries in the assessment are those have the highest fines for the caught offenders. In addition, the study claims that it is very important to use tools such as Automatic Identification System (AIS) and VMS for effective monitoring (Doumbouya et al., 2017).

A further study of the New Partnership for Africa´s Development, in 2016 (The Pan-African Fisheries, 2016), identified some examples of how African countries can stop illegal fishing activities, including:

- Community surveillance, to gather evidence of illegal fishing through reports from local fishers to fishery administrations;
- Increasing deterrence though successful prosecutions despite all the challenges and difficulties in following arrests through to successful prosecutions and the long time it took;

- Strengthening national-level interagency cooperation, to facilitate the sharing and cross-checking of information and to provide mutual support;
- Trade, market, and consumer initiatives assist in tightening controls, by establishing catch traceability systems and labeling to ensure market access for African legal fish. Examples of this are the South African Sustainable Seafood Initiative (SASSI[6]);
- Strengthening court systems, South Africa has an interesting example of work with environmental courts to help bring fisheries crime to successful prosecution and to increase the level of deterrence;
- Mixed results have been achieved with high technological options but that avoid technical problems such as IT support and equipment maintenance. This allows regional sharing of information through the internet or remotely based systems.
- At sea, observers to strengthen cross-checking.

Also, the study through these practical experiences, give some recommendations to help countries put an end to IUU fishing, including strengthening the governance framework to deter and stop illegal fishing, build capacity to successfully apply low-cost MCS and increase cooperation and awareness to fight IUU fishing (The Pan-African Fisheries, 2016).

Morevover, the evidence in that study shows that MCS is most effective where there are sanctions for breaking the rules, high likelihood of application of sanctions, high probability of being caught and all of these included in the legal and management frameworks (The Pan-African Fisheries, 2016).

[6] WWF initiative that implies education and easy-to-use tools as mobile applications and booklet (The southern african sustainable seafood initiative, n.d.).

2.2.4 Trends in MCS

The European Union System for fisheries controls employs new technologies to ensure that fishing fleets are monitored and controlled effectively and can cross-check information from many systems. The controls include (The EU system, n.d.):

- Electronic recording and reporting system (ERS) that is used to record fishing activity data , such as catches, landings, and sales. It replaces paper logbooks;
- VMS, a satellite-based fishing vessel monitoring system that gives data, such as vessel information, location, course and speed of vessels;
- Vessel Detection Systems (VDS), another satellite-based technology that helps to locate and identify vessels at sea;
- Automatic Identification System (AIS), which is a vessel identification and monitoring system that works with Very High Radiofrequency (VHF) and provides data, such as vessel information, position, course, and speed; and
- Flux Transportation Layer (FLUX TL), which is a messaging integration system to exchange fisheries control information.

In this sense Girard & Du Payrat, (2017) analysed the trends and new technologies in MCS and suggest that such technology is a potential game-changer for fisheries management in terms of achieving green growth in the sector. Some of the technology considered includes:

- Big data, which can be a great aid to sorting information, especially when there is vessel traffic intensity. Instances of this are Global Fishing Watch (Our Map, n.d.) and The Eyes on the Seas Project (Project Eyes on the Seas, 2015);
- Blockchain, which can be employed for tracking seafood products. An example is Earth Twine – Stratis Platform (World´s first seafood, 2017);
- Smart weighing system at sea, which calculates the weight of catches while taking into account the movement of the vessel, preventing miscalculation of the catch. Satellites send the data;

- Radio Frequence Identification (RFID[7]) technology, for traceability of fish products;
- Drones, which can be used for surveillance for assistance in securing a prosecution. An example of this technology is the association of the European Maritime Safery Agency (EMSA) and Market Marine company which are using Unmanned Aerial Vehicles (UAV) to track illegal fishing vessels (Vella, 2018);
- Onboard survey video camera and electronic monitoring, which can substitute to observers on board when recording bycatches. These cameras can broadcast the data from the vessels to monitoring centres

According to the last example of technology, cameras plus sensor, Global Positioning System (GPS) and software, were recently instaled on French tropical tuna purse seiners to complement the regular observer program in the Indian and Atlantic Oceans (Briand, Bonnieux, Dantec, Le Cotus, Bach, Maufroy, Relot-Stirnemann, Sabarros, Vernet, Jehenne & Goujon, 2018). This kind of technology is called Electronic Monitoring Systems (EMS) and is a tool used to collect fishing data including the amount of fish caught, fishing effort as the time spent fishing and bycatch (Electronic Monitoring Explained, 2017).

2.3 Artisanal fishing

2.3.1 Generalities

According the FAO "85% of the worldwide fishing fleet is artisanal and provides between 25% and 33% of the global fish catches" (The State of World Fisheries, 2016). However, the statistics related to the capture of products are submitted annually by member countries of FAO, and are potentially misleading due to the lack of attention that small-scale fisheries suffer in most parts of the world (Pauly & Zeller, 2016).

[7] Automatic identification technology which uses radio-frequency electromagnetic fields to identify objects carrying a usually samall tag when they como close to a reader.

FAO defines small-scale or artisanal fisheries as "traditional fisheries involving households (as distinct from commercial companies) using relatively small amount of inputs in capital and energy, and small boats making short fishing trips close to shore, mainly for local consumption" (Thiault, Collin, Chlous, Gelcich, Claudet, 2017).

On the other hand, according to a Spanish private fishing cooperative, when talking about protection of the artisanal fleet against industrial fleets it is assumed that (Industrial fleet vs. Artisanal fleet, 2017):

- Small vessels need public support to be economically viable;
- They are not major competitors in international trade and;
- They generally carry out ecological fishing less likely to deplete fisheries than large-scale industrial fishery.

Nevertheless, according to WWF, regarding whether subsidize artisanal fisheries, small vessels are already causing overfishing in fisheries around the world. Also, they can be major competitors in international trade. Besides, small vessels do not necessarily mean sustainability because they could be involved in overcapacity, overfishing or destructive practices (Small boats, big problems, 2008).

An essential part of WWF report shows the ambiguity in the definition of "artisanal" and mention that the difference between artisanal and small-scale does not have a common international definition, but varies from country to country. Nonetheless, they employ the definition of the World Trade Organization (WTO) that defines it regarding subsistence or near–subsistence activities (Small boats, big problems, 2008).

2.3.2 IUU fishing and MCS in artisanal fleet

A study by Myers & Yozell (2018) of the Stimson Center[8], suggests that "IUU fishing within artisanal fleets tends to fall into the unreported and unregulated categories".

[8] The Stimson Center is a United States Think Tank, a nonpartisan policy research center working to protect people, preserve the planet, and promote security and prosperity.

On the other hand, “an essential tool of MCS to help combat IUU fishing are the VMS systems” (Vessel Monitoring System, 2016). According to FAO, “a VMS provides real-time position, course and speed data of a fishing vessel through a communication link directly into a base station.” The most common communication link is the satellite (A fishery manager´s guidebook, 2009). However, currently, the data provided by VMS includes other information related to the fishing activity per se. In this sense, Myers & Yozell (2018) mention the artisanal fleet problems related to VMS. They affirms that, as VMS often requires an onboard power source, this system cannot monitor an artisanal fleet.

In this regard, FAO mentions that there is no unique MCS solution for all fishery situations and its shape varies according to different actors. It also provides vital factors that may influence the design of an MCS system (A fishery manager´s guidebook, 2009). One of the most important is the type of fishery. “For an artisanal fleet, the monitoring requirements are generally simpler than for an industrial fishery and may not require VMS, patrol vessels or aircraft” (A fishery manager´s guidebook, 2009). Two common approaches are, the community-based approach to participatory management and the use of government data collectors, or both in combination (A fishery manager´s guidebook, 2009).

2.3.3 New technologies for MCS for artisanal fishing

Some companies started, in the past decade, to produce alternative Vessel Tracking Systems (VTS) instead of AIS or VMS to solve the main problems including high costs and power source. These new devices are small, hand-held, low cost and employ cell phone technology (Myers & Yozell, 2018). Examples include a hand-held VTS developed by the company Pelagic DATA System (Providing data solutions, n.d.) and AST (Inshore vessel monitoring systems, n.d.). In general, the main technologies in new trends are as follows:

a. I-VMS

The United Kingdom Marine Management Organisation (MMO) regulated the employ the Inshore-VMS (IVMS). Such a system using GMS/GPRS[9] instead of satellite technology to reduce operating costs in the position reporting but only within managed areas. The potential of this system to be used offshore (12 nautical miles from the coast) and in all marine waters where small vessels operate is being explored (IVMS Device: Specification of requirements, 2014).

b. Video cameras

There are others alternative projects that intend to solve the problem of lack of VMS in artisanal fishing. Peru is the place of development of one of these projects, which consists of the installation, on board artisanal fishing vessels, a camera to identify and quantify captures (Bartholomew, Mangel, Alfaro-Shigueto, Pingo, Jimenez and Godley, 2018). Figure 5 shows a camera installed onboard an artisanal fishing vessel in Peru.

[9] Global System for Mobile Communications/General Packet Radio Service are digital mobile wireless telephone communication technology and standards that include the use of the Internet.

Figure 5. Camera installed onboard artisanal fishing vessel in Peru.
Source: Bartholomew et al. (2015)

c. Quick Response (QR) codes

Thai and Malaysian fishing authorities have been developing web applications based on QR[10] codes technologies. With this, fishing inspectors have an automatized tool that allows them an easy verification of the vessel and crew documents. In the case of Thai regulations, every vessel with a fishing license must have a QR code to be attached to the vessel´s control room, along with a marking, to be written on the front part of the hull of the vessel. This marking indicates the size, fishing gear and designated fishing area of the vessels (Thailand´s reform of fishing, 2016). In the case of Malaysia, all locally registered vessels have QR codes on a smart tag. Law enforcement personnel will be equipped with individual readers to scan QR codes and check the information about such vessels (Goula, 2017).

[10] It is a type of barcode that can be scanned using a QR scanner or a smarthpone with built-in camera and an adequate application.

d. Drones

i. Concept

An Unmanned Aerial Vehicle (UAV) or Drone is an aircraft with no pilot on board. It can be controlled remotely or can fly autonomously based on a pre-programmed flight plan. These last aircrafts types are more commonly known as Drones.

ii. Capabilities

Despite much theorical information about UAV´s, the most important practical issue is that their employment depends, in a strategic point of view, on their economic viability and, for operational and tactical employment, on their mission, the sensors installed in them, and their autonomy, as is shown in Figure 6:

Figure 6. Variables that affect operational and tactical UAV employment.
Source:. Own elaboration (2018)

In this sense, the time and distance that drones can work varies. Also, the equipment they can carry varies. Some drones only have a camera and a GPS, but there are also, for example, drones that can carry other types of devices, including infrared cameras or AIS sensors. (Andrews, 2016).

iii. Drones in the fishing sector

The world is adapting to drones very quick. Some exciting drone projects are focused on supporting sustainable fisheries, most of them in developing countries. One example is the use of these devices "for supporting law enforcement, patrolling specific marine areas in Belize instead of boats, due to their capacity of transmitting images that convey 3-15 centimeter per pixel" (Rosner, Molloy, Grez, Knowles, Wissell, Cuevas, Jacobs, Chandar & Farooq, 2017).

Likewise, there are other projects in Palau, Jamaica, and Costa Rica which employ camera-equipped drones to surveil and stream live video to control centers. They surveil to fishers, vessels and fish stocks. These devices "can detect and identify the vessels (if they are registered), fishing gears and they can relay near-time data on their location and movement" (Toonen & Bush, 2018).

2.3.4 Traceability

According to Borit & Olsen (2016), there are many definitions and standards of traceability. The challenge about them is to unify all of those in one international common standards. One definition, in reference to CDS and according to Hosh (n.d.), is that traceability is a market-based MCS tool that tracks and traces fish from the point of capture through unloading and throughout the supply chain. In this sense, the last trends in traceability include:

a. QR codes

Regarding traceability solutions as part of MCS measures for artisanal fishing, the International Seafood Sustainability Foundation (ISSF), in 2015, established in Indonesia, the Proactive Vessel Registration (PVR) project. The PVR is an "online and voluntary registry of small-scale fishing vessel owners which found to encourage responsible fishing and improve traceability, which should ultimately benefit the economic wellbeing

of fishers" (Proactive Vessel Registration, 2015). The project includes a PVR plaque with a QR code in the fishing vessel which can be scanned to get the main features of it. Figure 7 shows a hand-line fishing vessel with a sticker with a QR code tag in Indonesia.

Figure 7. A hand-line fishing vessel with a sticker with a QR code tag in Indonesia. Source: Proactive Vessel Registration (2015)

b. RFID tags

Another project from WWF, to strengthen tuna traceability to combat IUU fishing. The project employs a combination of RFID, QR codes and blockchain technology to capture information throughout the supply chain (Visser & Hanich, 2017). At the fish catch, in the vessel, fishers will use RFID tags to record information about the vessel and where, when and how they catch the fish. When the product is in the processing facility, it will receive a QR code that will track it to its final fate all the way past the retailer. A database based on Blockchain technology will register all this information (New Blockchain Project, 2018). Figure 8 shows a Tuna fish with RFID tags on board a fishing vessel in Oceania for traceability "from the vessel to the supermarket.

Figure 8. A tuna fish with RFID tag on board a fishing vessel in Oceania for traceability "from the vessel to the supermarket".
Source: New Blockchain Project (2018)

3 PERUVIAN FISHING

3.1 Generalities

The Ministry of Production regulates the fishery in Peru (PRODUCE by its Spanish acronym), and the primary legislation is the General Law of Fishery (Decreto Ley N° 25977, 1992) and its Regulation (Aprueban el Reglamento, 2001). In this Regulation, the classification of marine commercial fishing is as follows:

- Artisanal or small-scale: employing vessels up to 32.6 m³ of loading capacity and up to 15 meters in length, with a predominance of manual work.
- Small-scale: employing vessels up to 32.6 m³ of loading capacity, implemented with modern equipment and fishing systems, which extractive condition no have predominance of manual work.
- Large-scale: employing vessels larger than 32.6 m³ in loading capacity.

Figure 9 shows the classification of Peruvian marine commercial fishing.

Figure 9. Classification of Peruvian marine commercial fishing.
Source: Own elaboration (2018)

Another critical regulation, includes the Fishing Management Regulations of the fishing resources as differential units with access regime, fishing seasons and specific fishing

methods (Planes de manejo pesquero, 2016). The General Law of Fishery contains these Fishing Management Regulations. They also consider the conditions to grant fishing rights, the magnitude of the fishing effort, the permissible captures quotas, fishing zones, fishing gear, fishing fleet features, minimum sizes, permissible captures of bycatch, control systems, fishing resources loading verification, precautionary measures of environmental assessment and the fees related to exploitation rights (Información sobre la ordenación, 2003).

Some examples of the principal Fishing Management Regulations include the following species: anchovy, sardine, mackerel and horse mackerel (Pelagic fishery), hake (Demersal fishery), artisanal fishery and others like giant squid, deep cod and thunnini (Visión general del sector, 2010).

3.2 Measures against IUU fishing

An important measure to prevent IUU fishing in Peru, focussed on foreign flag vessels, is its adherence, in 2017, to the PSMA (Peru joins Port, 2017). This agreement driven by FAO allows the country to align with the international regulation that fights against IUU fishing and exchange information with 76 countries in which the treaty already governs. Also, it can use the treaty as a tool to prohibit entry to the fishing ships that do not comply with fishing regulations in other countries (Perú implementará a partir de Octubre, 2017).

However, on September 5th, 2018, during the review stage of the present dissertation, PRODUCE legalized the interdiction of illegal fishing activities, which will enter into force in October 2018 (Decreto Legislativo N° 1393, 2018).

3.3 Situation of artisanal fishing

The Peruvian artisanal fleet generates US 2,400 million dollars (87%) and 200,000 jobs (69%) versus the industrial fleet, which generates US$ 1,000.00 millions dollars (31%) and 31,000 jobs (13%) (En Perú, la pesca, 2013). However, traditionally, the artisanal

fishery in Peru has been recurrently abandoned by the governments. A clear example of this is the fact that just in 2012, the first statistics were obtained on this type of economic activity in the Peruvian history (Medicina, 2014).

As a result, as many studies mention, the root of the artisanal fishing problems are the high informality in the sector that causes low productivity (Medicina, 2014) and which seems to be a vicious circle that never ends.

3.3.1 High informality and IUU fishing

The statistics of 2012 showed a total of 15,701 artisanal fishing vessels of which only 39.12% had fishing licenses (FL) (Medicina, 2014). According to that report, the regions with the most artisanal fishing vessels in the country are Piura (34.7%), Lima (13.7%) and Ancash (11.6%). However, less than 40% of them have FL (Galarza & Kamiche, 2015). That is to say, from the total only 6,143 vessels were under the control of fishing authorities. In other words, there were around 9,558 (60.88%) artisanal or small-scale fishing vessel that could be engaged in IUU fishing. Figure 10 shows the number of vessels with and without FL, by region.

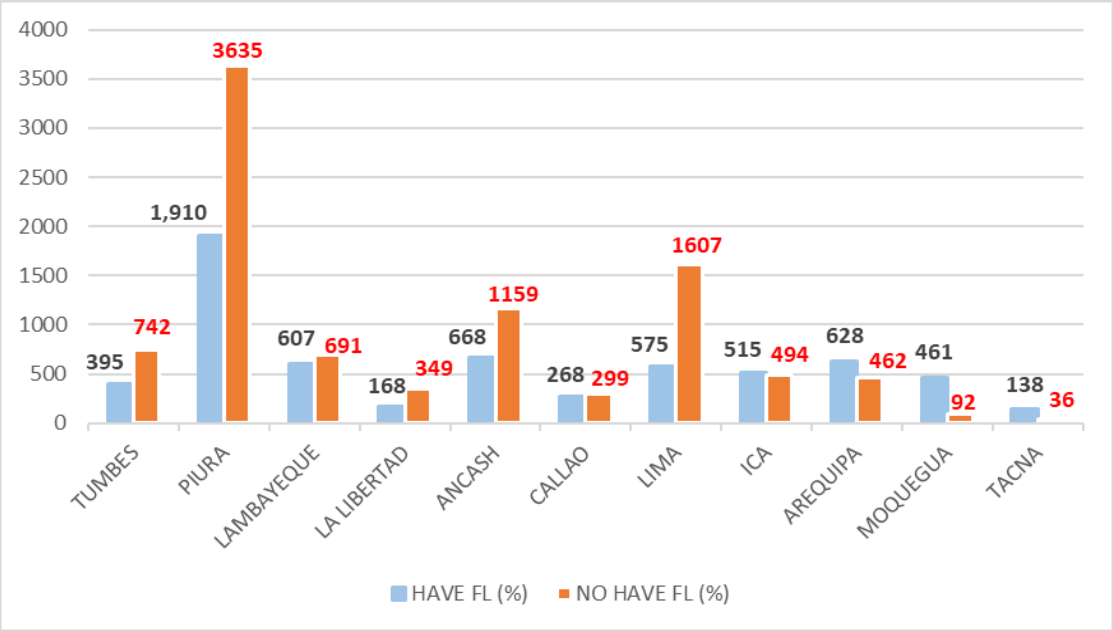

Figure 10. Amount of fishing vessels with and without Fishing License (FL), by region. Source: Anuario Estadístico Pesquero (2012).

While it is true that IUU fishing is often related to foreign vessels fishing illegally, it also occurs with artisanal and small-scale national fishing fleets (The challenge of, 2014). In the best the of cases, as a study of 2018 suggests, "IUU fishing within artisanal fleets tends to fall into the unreported and unregulated categories" (Myers & Yozell, 2018).

According to a study by Mendo and Wosnitza-Mendo (2014) about the reconstruction and re-estimation of the catch statistics of Peruvian fish between 1950 and 2010, "the correction factor for unreported artisanal fishing captures fluctuates between 28 and 40%". That is, the actual amount of captures by small-scale fishing vessels during that period was 35% higher than reported (López, 2016)

However, according to Oceana, the most common forms of IUU fishing in Peru include fishing in MPA, and the invasion of the five exclusive miles for artisanal fishing carried out by large-scale vessels or vessels that practice trawling. Others are, the lack of respect for temporary closures of fishing seasons, failure to report discards and the fishing of young species over legal limits (Pesca ilegal, n.d.). Even though the publication did not mention it, apparently these kind of IUU fishing are related to events inside the Peruvian jurisdictional waters and by the national flag fleet.

According to the census of 2012, from 15, 701 fishing vessels, 2,475 did not have vessel registration certificates[11] (VRC) (Anuario Estadístico Pesquero, 2012). That is, the owners of more than 15% of the total artisanal fishing vessels could not demonstrate legal origin of the vessel. Therefore they could not register them in the National Public Records. Figure 11 shows the number of vessels with and without VRC, by region.

[11] The VRC must be renewed anually.

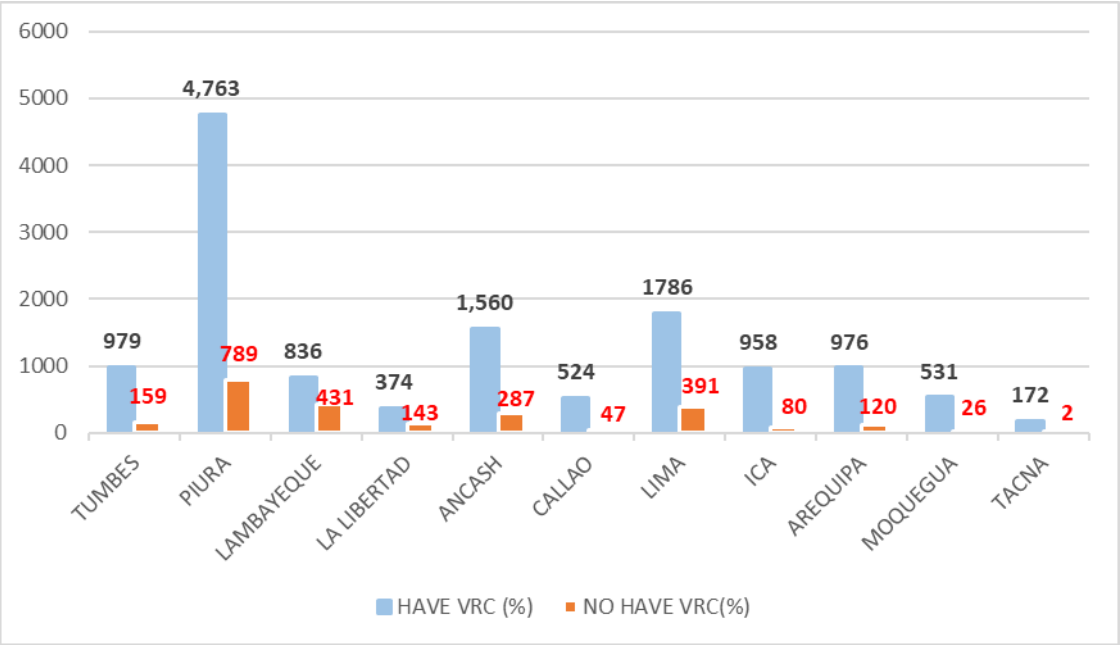

Figure 11. Amount of fishing vessels with and without the Vessel Registration Certificate (VRC), by region. Source: Anuario Estadístico Pesquero (2012)

When a vessel does not have this important document, it may be because it could be engaged in illegal activities. In Peru, the authority in charge of repressing illicit activities in the aquatic environment is the General Directorate of Captaincies and Coast Guard of the Peruvian Navy (DICAPI), which is also the Peruvian Maritime Authority. Regrettably, DICAPI does not have specific statistics about the artisanal fishing vessels engaged in this kind of illegal activity. However, in the report of piracy and armed robbery against ships during 2016, due to the modality of facts and occurrences in Peru, it can be deduced that, small vessels and probably many of them, artisanal fishing vessels, were responsible for most of the illicit activities mentioned in the such report (Piracy and armed robbery, 2017).

In this regard, according to a study by Galarza and Kamiche (2015), only 22.4% of the artisanal fishing vessels are registered in the National Public Records. That situation also causes another kind of problem; the vessels cannot be capital assets. Therefore there is no possibility to use them as a financial operations warranty or to access credits. In this situation the financial sources for the fishing task (buying of ice, feeding the crew or oil) mainly come from the merchants of the product, who buy their fish. Consequently, this condition has an impact in the value chain of artisanal fishing because usually the fishers, who received the money from the merchant, cannot negotiate a better price or look for

another buyer because the merchants have control of the operations (Galarza & Kamiche, 2015). Figure 12 shows the vicious circle in the value chain in the artisanal fishing activity.

Figure 12. Vicious circle in the value chain in the Peruvian artisanal fishing activity.
Source: Own elaboration (2018)

In an analysis of the causes of informality, the main reasons for the lack of registration in the National Public Records are ignorance, economic factors and red tape (Galarza & Kamiche, 2015). Figure 13 shows the reasons why fishing vessels do not register in the National Public Records, by region.

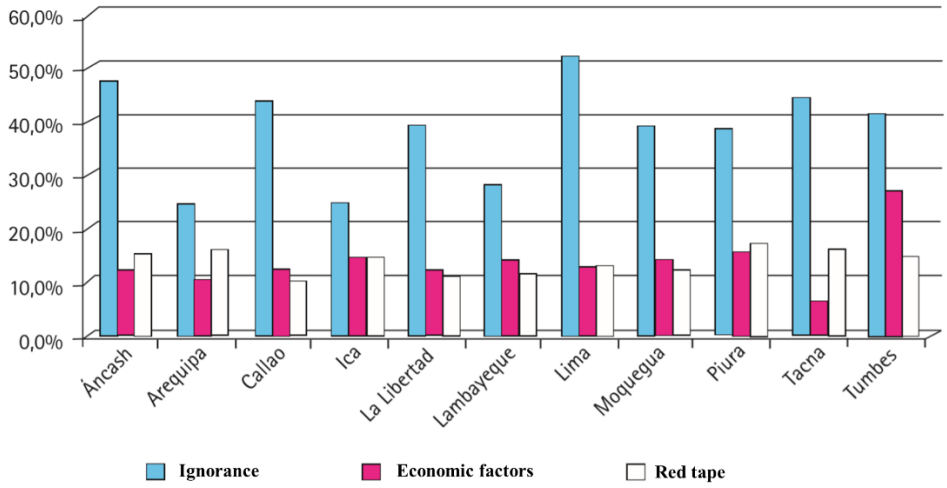

Figure 13. Reasons that explain fishing vessels not register in the National Public Record.
Source: Galarza & Kamiche (2015).

To solve the problem of the informality in the sector, the government established in 2016 the System of Artisanal Fishing Formalisation (SIFORPA, by its acronym in Spanish) (Decreto Legislativo N° 1273, 2016). With this important measure, PRODUCE granted enormous temporary facilities to artisanal fishers with vessels of less than 6.48 units of gross tonnage to obtain FL and VRC through an online application and compliance with minimum requirements.

It is important to mention that PRODUCE or the Regional Government, depends on each case, grant the FL and DICAPI grant the VRC. To obtain an FL, the VRC is a requirement.

Finally, this temporary measure, SIFORPA, finished at the end of 2017 and still, there are not officials results or statistics to measure its performance.

However, similar to the interdiction activities regulation, on September 5th, 2018, during the review stage of this dissertation, PRODUCE legalized the conditions of a new SIFORPA for artisanal fishing vessels from 6.48 units of gross tonnage to 32.6 m^3 with a new regulation. This measure will start in October 2018, and it will continue for two years (Decreto Legislativo N° 1392, 2018).

3.3.2 Monitoring, control and surveillance (MCS) of Peruvian artisanal fishing.

PRODUCE is the authority in charge of the control of fishing affairs and DICAPI of the vessel and security matters. Those authorities have the following MCS measures:

a. Fishing inspectors

PRODUCE, for the application of MCS measures in the artisanal fleet, has fishing inspectors along the coast in all regions. As specific activities, the inspector should inspect and control fish unloading points and other places, compliance with regulations on permissible captures, minimum sizes, size of fishing gear, tolerance percentages, fishing zones, no fishing seasons and satellite monitoring systems (Programa de vigilancia, 2009). In addition, they have to control the fishing vessels in relation to fishing licenses, documentation, compliance with regulations, their operational situation and conditions and equipment installations of recording of capture (Programa de vigilancia, 2009).

In this regarding, according to a PRODUCE document, in 2013 there were 211 inspectors in all the Peruvian regions that work for them. They have jurisdiction over all the fishing vessels. Also, this Ministry outsources the services of 650 private inspectors, but they only can control industrial anchovy vessels (Experiencia de éxito, 2013). However, according to information from some inspectors, when the anchovy fishing season is over, they could inspect other kinds of fisheries in some specific cases and with the authorization of PRODUCE.

According to a study in 2012, the main issues founded in such inspections were (Experiencia de éxito, 2013). :

- High crime rate and difficulty accessing certain landing sites;
- The informality of artisanal fisheries, normative ignorance of the agents involved in the sector;
- Exposure of supervising personnel to corrupters;
- Execution of supervision activities without articulating efforts with other entities with competencies in inspections, lack of a system for recording activities of supervision

b. Vessel Monitoring System (VMS)

In relation with the VMS in Peru, according to the General Law of Fisheries, the objective of the Peruvian satellite monitoring is to contribute in the adoption of management fisheries measures and responsible exploitation of the resources (Aprueban el Reglamento, 2001). The VMS, called Satellite Tracking System (SISESAT by its acronym in Spanish), is compulsory for large-scale fishing vessels with national and foreign flags. Likewise, it is compulsory for small-scale fishing vessels that carry out extractive activities of the anchovy resource and; other fishing vessel according to the specific Fishing Management Regulations (Decreto Supremo N° 001, 2014).

Moreover, in 2016, PRODUCE incorporated the area of application of SISESAT to all holders of rights of fishing licenses that perform extractive activities of the resources of anchovies regardless of the destination of such resource (both, direct and indirect human consumption). In this regulation, artisanal vessels with an outboard engine and loading capacity less than ten cubic meters are excluded. The Ministry also includes the compulsory use of an electronic logbook and the progressive application of other electronic devices, such as video surveillance cameras (Decreto Supremo N° 024, 2016). However, according to this norm, the regulation concerning electronic logbook and cameras for artisanal vessels involved in the extraction of anchovies for direct human consumption is going to be progressive and in a concordance with specific regulations from PRODUCE[12].

Nevertheless, in 2017, PRODUCE published the Fishing Management Regulation for anchovy resources for direct human consumption (Decreto Supremo N° 005, 2017). In the area of application of this regulation are including the artisanal and small-scale fishing vessels involved in extraction activities of the anchovy resource for direct human consumption. One requirement to be allowed to extract this resource for direct human consumption is to have on board monitoring satellite equipment or another alternative system according to the current regulations of the SISESAT. Figure 14 shows the vessels within the area of application of the SISESAT.

[12] According to a new regulation of PRODUCE, the electronic logbook is compulsory from November 22, 2017, to all the fishing vessels which have the SISESAT installed. (Comunicado N° 014, 2017)

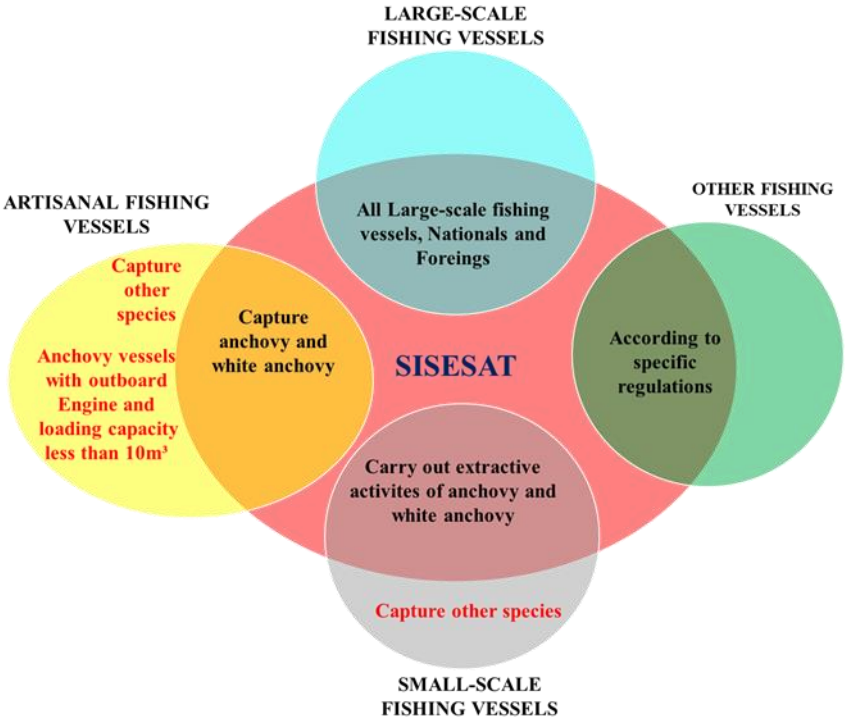

Figure 14. Vessels within the area of application of SISESAT.
Source: Own elaboration (2018)

As we can notice, in the case of artisanal fishing vessels, PRODUCE only controls those that carry out anchovy extractive activities. Regrettably, in the census of 2012, there is no data about the number of artisanal fishing vessels engaged in anchovy captures. Nevertheless, according to information provides by some of the inspectors, no artisanal fishing vessel has installed the SISESAT (personal communication, August 20, 2018). Likewise, according to information provided by some fishers, there are two reasons to avoid the installation of SISESAT in their vessels: the cost of the satellite service and the fact that they do not want to be under control due to go fishing to unauthorized zones (personal communication, August 20, 2018).

On the other hand, DICAPI has its own Satellite Tracking System, called Aquatic Traffic Information and Monitoring System (SIMTRAC, by its acronym in Spanish). In relation to the Peruvian fishing fleet, the regulation of such a system includes all the industrial fishing vessels and all vessels with a gross tonnage higher than 6.43 that operate more than 15 nautical miles from the coastline (Decreto Supremo N° 008, 2011).

Even though the purpose of the SIMTRAC is to monitor the aquatic traffic as an effective tool of maritime control instead of fishing control (Decreto Supremo N° 008, 2011), its features allow it to be a complement to the SISESAT. For the specific case of the artisanal and small-scale fishing fleet, the SIMTRAC allows monitoring not only artisanal anchovy fishing vessels but also all other vessels involved in the capture of other species, if they go outside 15 nautical miles from the coastline. This regulation includes the anchovy vessels with outboard engines that have a loading capacity off less than 10m³; both cases exclude the SISESAT. Figure 14 shows the complementation of areas of application between SISESAT and SIMTRAC.

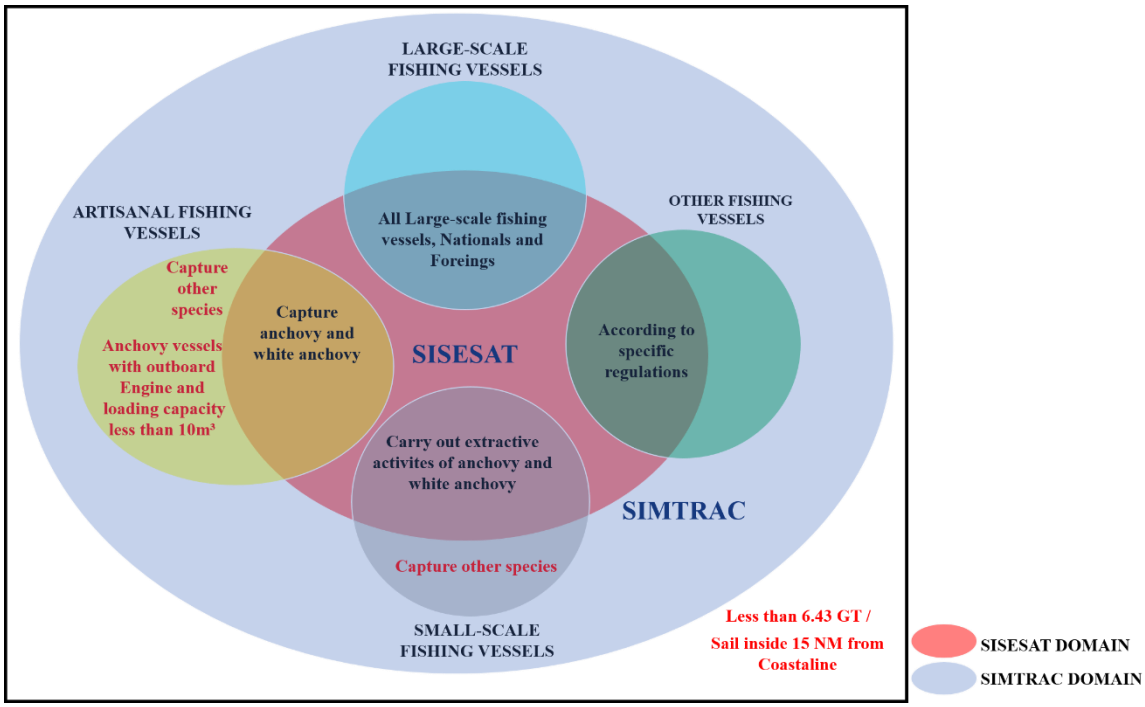

Figure 15. Complementation of areas of application between SISESAT and SIMTRAC. Source: Own elaboration (2018).

However, according to information provided by the current technical personnel in charge of the system, in relation with fishing activities, there are only a few vessels less than 32.6 m³ that comply with this regulation (personal communication, July 16, 2018). Like the SISESAT case, according to information provided by some fishers, there are two reasons to avoid the installation of SIMTRAC in vessels: the cost of the satellite service and the

fact that the fishers do not want to be under control due to fishing in unauthorized zones (personal communication, August 20, 2018).

Simultaneously to the review stage of the present study, in September 2018, PRODUCE, according to the new process of formalization legalized the mandatory use of satellite devices or another alternative system on board all the vessels from 6.48 units of gross ton to 32.6 m³ (Decreto Legislativo N° 1392, 2018). However, in the best of cases, after two years of formalization, vessels of less than 6.48 gross tons will not be part of the system either, just as they are not now.

On the other hand, DICAPI has other means of fulfilling their functions of surveillance and control of the maritime activities. The main ones are Coastguard inspectors, coastal radars, patrols vessels, and aircraft. A SIMTRAC integrates all of them. Also, prior coordination, these means can support the work of PRODUCE. Figure 16 shows the integrated subsystems of the SIMTRAC of DICAPI:

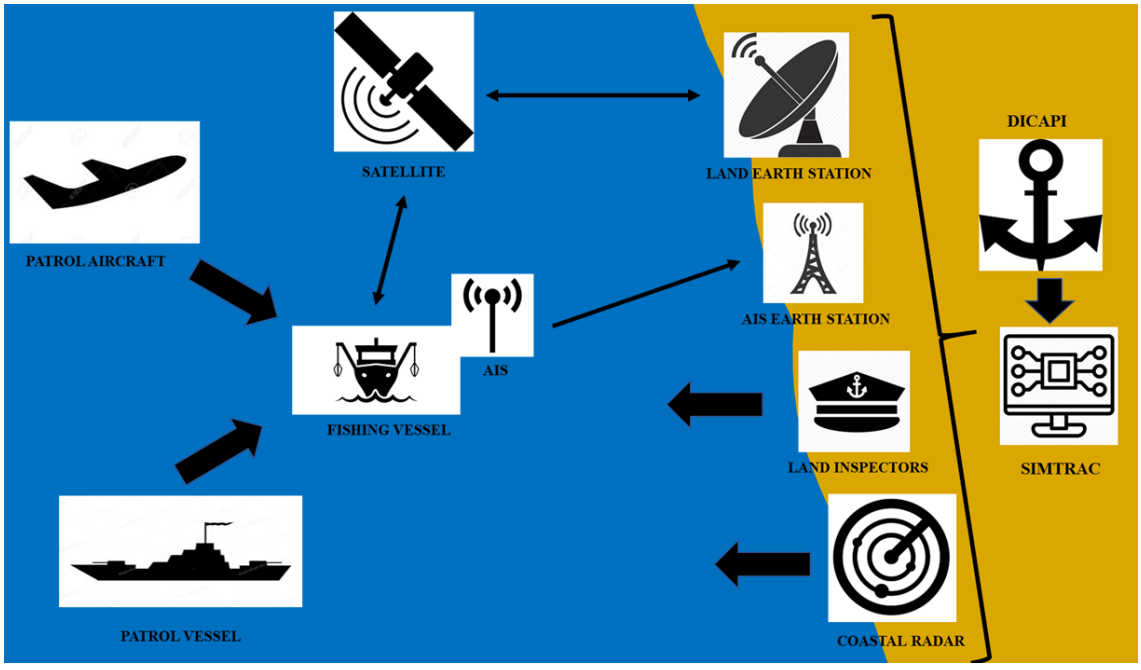

Figure 16. Integrated subsystems of the SIMTRAC of DICAPI.
Source: Own elaboration (2018).

Finally, Gutiérrez and Sueiro (2017) recommends that SISESAT should include the whole artisanal fleet and, in turn, this system should be integrated SIMTRAC, considering the offer of more affordable and practical technological alternatives than real-time emissions for small vessels (AIS for instance). Moreover, it recommends that the generated information should be open to applications such as monitoring protected areas, economic studies, business management, ecosystemic studies and increasing surveillance with civil society participation.

c. Traceability

Concerning the traceability of fishery resources, PRODUCE has implemented the Sourcing Certificates (SC) and Simplified Catch Certificate (SCC), which are official and non-automated (manual) forms and must be signed by fishing authorities. The SC is nothing more than a physical sworn statements forms based on commercial documents between fishers, merchants, and processing plants. These Certificates should also be signed by fishing authorities, and they serve to check the legality of the product during inspections. The SCC is a requirement for exportation (Guía de requisitos, 2016).

Taking an instance of Peruvian mahi-mahi production (Traceability of the Peruvian mahi-mahi fishery: Assessment and proposal, 2017), it is possible, to sum up, the traceability process as following:

d. Capture: The ubication of the capture of the species (fishing zone) is recorded manually by the fishers in the personal logbook, but it is private information and no possible to share. Then, when the fishers are landing the products, the PRODUCE inspectors record manually the information only about the fishing amount. Also, the fishing wharf[13] manager records the same information for commercial purposes (wharf fee services).
e. Trading: In this phase, the land transporting vehicle receives the product with a Waybill with information about the features of the product transported (amount and weight). Also, in this phase, the most important document in the Peruvian traceability

[13] According to a study from 2013, in 2011 there was 45 authorized fishing wharfs for unloading the products, which 89% were operative (Estudio de desempeño ambiental, 2013).

of the artisanal fishing is generated, the SC. The SC is required by the PRODUCE inspectors when the product is loaded on board the vehicles (an aleatory inspection). However, it is not a requirement by the processing plants receiving the fish. Also, the SC is just a sworn declaration carried out by the merchant of the product or fishers and a verification by the authorities is usually not required due to their lack of capacity.

f. Processing: when the vehicles arrive at the processing plants, they should give information about the fish supplier, capture and landing wharf consigned in the Waybill. The plants require from the vehicle FL, VRC and Sanitary Protocol of the Vessel (SP). On the other hand, the plants issue a Raw Material Reception Record (RMRR) detailing the total weight by classification and origin of the product.

g. Exportation[14]: This phase generates important documents including the Certificate of Origin (COO) which guarantees that Peru exports the products. Also, when a product goes to the European Community, a Simplified Catch Certificate (SCC) is required, based on the SC. Figure 17 shows the flow of the main stages in the artisanal fishing traceability process.

[14] Obviously, when the product goes to the internal market this phase is not included.

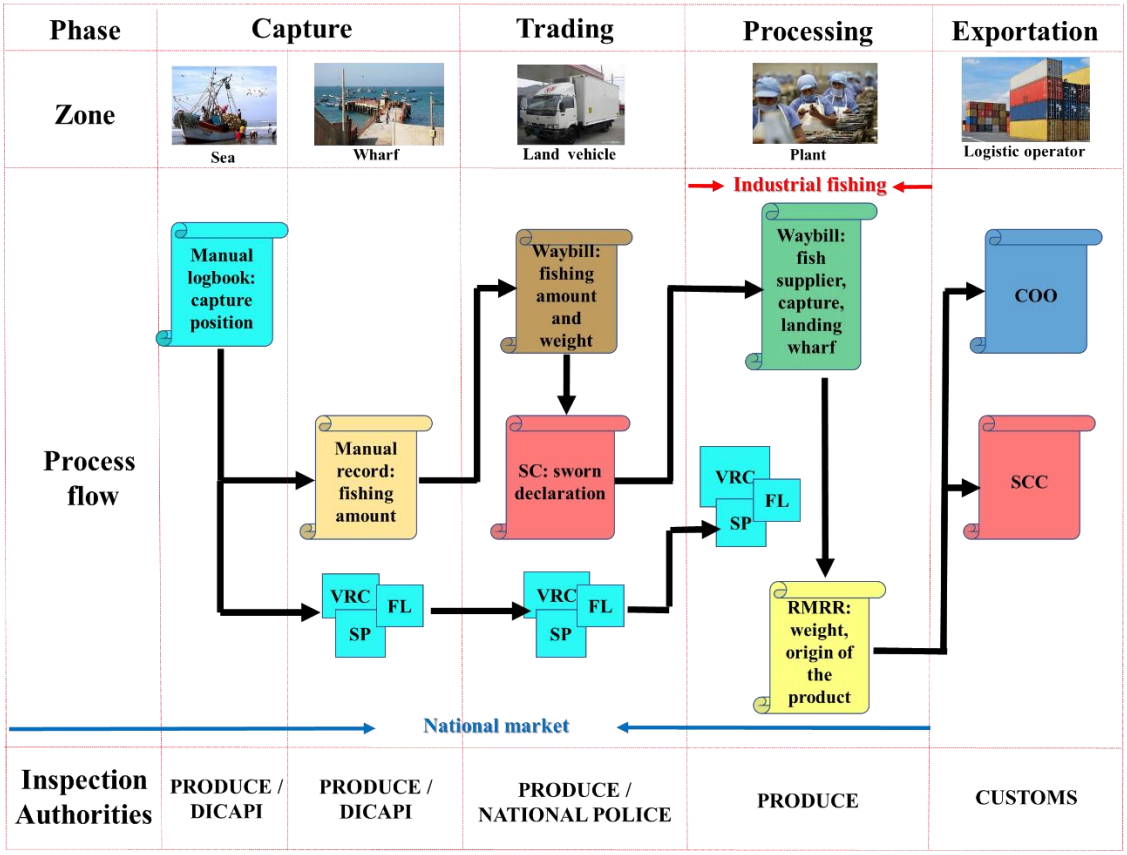

Figure 17. Flow of the main processes in the artisanal fishing traceability. Source. Own elaboration (2018)

3.4 MCS for achievement of Sustainable Development Goal (SDG) 14, target 14.b in Peru

3.4.1 Generalities

In Peru, the focal point for coordinating and monitoring the SDGs is the National Strategic Planning Centre (CEPLAN by its acronym in Spanish). This Centre is incorporating such SDGs into the National Development Strategic Plan for 2021 and update for 2030. Also, based on that Strategic Plan, the different sectors of the government are updating their Multiannual Sectorial Strategic Plans which including aspects of SDG.

In this sense, part of the present work focuses on the SDG 14, target 14.b: Provide access for small-scale artisanal fishers to marine resources and markets, which the PRODUCE sector is in charge of.

3.4.2 Connection between MCS and target 14.b, SDG14, provide access to marine resources and markets

Access to resources "is related to the overfishing threat because around 90% of the fisheries of the world are overfished. Access to markets is related to local and foreign markets not possible now due to the lack of international standards and sustainable practices" (Artisanal fishers are on the frontline, 2017). Likewise, access to resources is related to the competition with large-scale fishing and other activities including tourism, aquaculture and energy and access to the market to poor flow benefits in the value chain (How International Community, 2017). As we mentioned in the previous chapters, all those issues are connected to MCS measures, including traceability, in this case, for artisanal fishing. Therefore, improving MCS measures could help to the fulfillment of the target 14.b, SDG14.

3.4.3 Indicators issues

The United Nations (UN) indicator for SDG, target 14.b, "progress by countries in the degree of application of a legal/regulatory/policy/institutional/framework which recognizes and protects access rights for small-scale fisheries" "it is not a SMART[15] indicator and would require clarification of the institutional framework within which, action would take place" (Recuero, 2017). Maybe, that is the reason why INEI, the governmental Peruvian organization in charge of SDG indicators, is not yet working on the indicator of target 14.b (Perú: Sistema de Monitoreo, n.d.).

On the other hand, PRODUCE established some indicators to measure their performance regarding their Strategic Plan. Despite these indicators are not made specifically to measure the SDG14, they are more "SMART" than those elaborated by the UN to help in the measure the fulfilment of target 14.b. Likewise, due to their connection, also these indicators could help to measure some MCS measures related to IUU fishing, the value

[15] SMART: Specific, measurable, achievable, relevant and time-oriented.

chain productivity and access to marine resources and markets to artisanal fishers. The following Tabla show the PRODUCE indicators.

Table 4. Indicators for Strategic actions in the Multiannual Sectorial Strategic Plan of PRODUCE

Strategic Action	Indicator
Promote the formalization of artisanal fishing activiy	Percentage of formalized artisanal fishing vessels
Promote the financial access to economic units of artisanal fishing	Percentage of economic units of fishing sector with access to financing
Promote the internal trade of fishing products	Annual per capita fish comsumption
Strengthen the management of fisheries by making sustainable use of resources	Coverage of supervision and control of fishing activities

Note: Data from Multiannual Sectorial Strategic Plan of PRODUCE. (2017).

4 RESEARCH METHODOLOGY AND DATA ANALYSIS

The present chapter deals with the analysis of open information on different aspects of IUU fishing and the various measures to fight it, searching for a new design for a MCS system that may be suitable for artisanal fisheries in Peru. It also assesses the connection between MCS and access of artisanal fishers to marine resources and markets in Peru, as it pertains to target 14.b of the Sustainable Development Goal N°14.

4.1 Research Methodology

To collect the information for the research, a mixed approaches combining qualitative and quantitative research was adopted (Schoonenboom & Johnson, 2017).

First, qualitative content analysis based on specific material and the main important themes for the study was conducted (Bryman, 2012). Then, to obtain specific information about points of view of particular sectors, such as fishing inspectors, and information and communication technology (ICT) technicians of PRODUCE, as well as artisanal fishers, semi-structured interviews were employed. It is important to mention that they are very closed sectors and it was important to gain their confidence (Bryman, 2012). Finally, questionnaires were employed to collect information from a large number of Peruvian Navy coleagues of the author, who have a very similar background, expertise and organizational cultures of work.

4.1.1 Qualitative content analysis

In the current information society, where there is an overwhelming avalanche of data, the main problem is not to obtain data but to digest it properly and use it in a practical way to solve specific problems (Tinto, 2013). In this sense, a content analysis was employed, which is "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (Krippendorff, 2004).

For the present research, the objective of the content analysis was to know the different aspects of IUU fishing along with the various measures to combat it worldwide, specifically in artisanal fishing in Peru. Also, the objective was to know the relation between MCS and the access to marine resources and markets (SDG 14) for artisanal fishers. A total of one hundred twenty-seven publications, of varied types, were obtained from open databases from the internet and reviewed. These were included in Chapters 2 and 3 of the present work.

In this sense, the information was divided into eight categories:

a. Roots and consequences of IUU fishing;
b. Common features of IUU fishing;
c. MSC traditional approaches for artisanal fisheries;
d. Measures can stop IUU fishing
e. New trends in MCS technology for artisanal fisheries;
f. Specific practical examples of uses of technology for artisanal fishing
g. The connection between IUU fishing and other criminal activities;
h. Details of IUU fishing in Peruvian artisanal fleet; and
i. The connection between SDG 14, target 14.b and IUU fishing.

4.1.2 Interview questions

The interview, as a research method, "is a specific way of conversation in which knowledge is generated from the interaction between an interviewer and interviewe,

effectively providing useful and valid data from what the participants say to broadcast their messages or express their ideas or emotions" (Robson, 2002).

The objective of the interviews for the present work was to collect information about the work of PRODUCE regarding MCS. Furthermore, the intention was also to collect information to understand the behaviour of artisanal fishers in relation with the MCS main measures.

The interviews were based on the knowledge, practical experience and skills of the participants. Semi-structured telephone interviews were conducted with eighteen experts. The questions were semi-structured not only to confirm some known information but also to collect not just answers but the reasoning behind their answers (FAO, n.d.).

The participants are fishing inspectors and ICT technician from PRODUCE as well as artisanal fishers. They were divided into three groups with different questions for each group, according to their speciality. The groups are as follows:

- First group: PRODUCE fishing inspectors;
- Second group: fishers that are currently the presidents or general secretaries of some Artisanal Fishing Unions (OSPA in Spanish);
- Third group: technicians in ICT.

a. First group: fishing inspectors of PRODUCE

The first interviews were conducted with all eight regional heads of the fisheries inspectors of PRODUCE who currently work in nine Peruvian coastal regions of that Ministry. That is to say, all regional heads were interviewed. Each of them has more than five years of experience as inspectors, and they are fishing engineers or biologists. Only one of them was a woman. They were chosen because of their main functions. Apart from carrying out the inspections, they are in charge of a group of inspectors and lead the planning and execution of their activities. It is important to mention that all the interviews were conducted within a cordial environment and 100% of those interviewed answered

all of the questions. Table 5 shows the number of inspectors than each head of is in charge of, for each region.

Table 5. Number of inspectors for each head of the region

Region	Amount of inspectors
Tumbes	10
Piura	35
Lambayeque-La Libertad	6
Anchas	51
Lima-Callao	34
Ica	20
Arequipa	10
Moquegua-Tacna	4

Note: Each region have a head of region. Own elaboration. (2018).

The questions for this interviews were divided into three categories, for a better understanding of the information: features of IUU fishing, problems in their inspections, traceability and the employment of SISESAT.

b. Second group: fishers that are currently the presidents or general secretaries of some OSPAs

In the same way, the second round of interviews were conducted with the presidents or general secretaries of seven OSPAs in the coastal regions. All of them have more than 20 years of experience as artisanal fishers. All of them are men.

The OSPA were chosen because of their location in the areas of greatest artisanal fisheries in terms of -vessels and fishes- and also because of its importance in the region, according to the heads of the fisheries inspectors of PRODUCE. Also, it is important to mention that all the interviews were conducted within a cordial environment and 100% of those interviewed answered all of the questions. Table 6 shows the approximate number of associates of each artisanal fishing union in the present study.

Table 6. Approximate number of associates of each artisanal fishing trade unions in the study

Region	Union location	Approximate number of associates
Tumbes	La Cruz	300
	Zorritos	300
	Cancas	300
Lambayeque	San José	400
	Santa Rosa	400
Anchas	Chimbote	80
Moquegua	Ilo	2500

Note: Own elaboration. (2018).

In the same way, the questions for these interviews were categorized into three groups, also for a better understanding of the information: formalisation of their activities, installation of monitoring devices and services on board and traceability of their products.

c. Third group: technical ICT personnel

This group was established due to the importance of knowing the main technical ICT features of the SISESAT and SIMTRAC, in a general sense. The following three experts were interviewed:

- One technician from DICAPI who was in charge of the SIMTRAC almost for ten years;
- A systems engineer who also worked in the SIMTRAC and then on projects for Collecte Localization Satellites (CLS), the French company that owns the platform on which SIMTRAC and SISESAT is based; and
- An engineer that is currentlly in charge of the system for PRODUCE as general coordinator of the monitoring system.

All the interviews were conducted within a cordial environment and 100% of the interviewe answered all of the questions.

4.1.3 Questionnaires

Questionnaires are widely used to collect data from surveys and can be administered without the presence of the researcher (Cohen, Manion & Morrison, 2007). Thus, to collect the information, digital questionnaires created in Google forms were sent to sixty Coast Guard officers of DICAPI. However, only twenty-two of them responded (36.66%). The total number of questions was thirteen, of which twelve were closed, and only one was open, to avoid consuming too much time and achieve the largest possible participation of those asked (Dörnyei, 2003).

The objective of the questionnaire was to obtain information about the perceptions of the officers about the main features of the work by DICAPI in relation to monitoring, controling and inspecting artisanal fishing vessels and contrasting them with the researched information.

The officers interviewed have between five to thirty years of experience and have worked or are working in different rotative administrative and operational areas of the Peruvian maritime authority in technical departments, Coast Guard Operations Command, harbour masters, and Coast Guard patrol vessels. The rank of the Officers varies from Lieutenant to Captain. The administrative work includes vessel measure inspections, vessels construction inspections, and vessel registration. On the contrary, the operational work includes vessel and fishers inspections in wharfs and at sea. Further, their work includes the employment of the different means of MCS. Only one of them was a woman.

Figure 18 shows a map with information about the research data collection by interviews and questionnaires.

Figure 18. Map with the location of the interviewees and people who answered the questionnairies. Source: Own elaboration (2018).

4.2 Data analysis

After reviewing the different aspects of IUU fishing in the world, including the main measures to combat it through information from many and varied organizations, including governments, international agencies, non-governmental organizations and researchers, and focusing on the area of the present study, Peru, we will get information through qualitative content analysis, interviews and questionaries.

4.2.1 Qualitative content analysis results

The following information was obtained from theoretical review, for each category:

a. Roots and consequences of IUU fishing

The main roots of the incidence of IUU fishing are related to poor governance and inadequate control by the authorities, which causes some of the consequences detailed in Table 7, globally and for Peru.

Table 7. IUU fishing roots and consequences

Scope		Main roots of IUU fishing	Consequences
	Globally	Lack of logistics	Low capacity of purchase, maintenance and operation of means as patrol vessels and aircrafts
		Lack of good system of vessel identification	Increases the ability for vessels to hide behind a new identity
		Lack of seafood traceability	Increases probability of fish caught and sold ilegally
		Poor multisectorial cooperation	Lack of integrated measures
Peru		Low capacity of MCS	Low capacity for an effective enforcement of regulations
		High informality	Increases the ability of ships to hide behind an absence of identity and the probability of doing illegal acts
		Low productivity of the value chain	No access to artisanal fishers to marine resources and markets
			No access to formality

Note: Adapted from Jenning by Shark Research (2014) Galarza & Kamiche by Pacific University (2015) and Medicina by Lima University (2014).

b. Common features of IUU fishing

The most common types of IUU fishing globally and in Peru are shown and compared in Table 8:

Table 8. Common features of IUU fishing.

Usual methods		Common features of IUU fishing	Practical examples
Fish laundering	Ports of Convenience	Fishing without a license or quota form some kind of species	Informality
		No reporting catches or making false reports	No real control over fish stocks
		Fishing undersized fish or fish that are sheltered by regulations	Fishing of young species over legal limits
		Fishing in close areas or during closed seasons and using not allowed fishing gear	Fishing in MPA
			Invasion of exclusive zone for artisanal fishing by large-scale vessels
			Lack of respect to temporary clousures of fishing seasons
			Discards not reported

Note: Adapted from Cutlip by Global Fishing Watch (2016), Illegal, Unreported and Unregulated fishing by Center for Strategic & International Studies (2017), Pesca ilegal by Oceana (n.d.) and Medicina by Lima University (2014).

c. MSC traditional approaches for artisanal fisheries

In respect to MCS, there are no unique for all fisheries; the solutions should be shaped according their type, in this case to the artisanal fishery. For that reason, international organizations recommend two types of approaches for such fisheries, both are currently applied in Peru, which are shown in Table 9:

Table 9. MCS approaches of FAO for artisanal fisheries

MCS approaches	Description
Community-based approach	Community surveillance through the report from local fishers to fishery authorities
Government data collectors	Observers and inspectors

Note: Adapted from A Fishery Manager´s Guidebook by FAO (2009).

d. Measures can stop IUU fishing

There are many measures that international community has been taking to stop IUU fishing. However, a good way is given by an African study, showe in Table 10.

Table 10. Measures that can stop IUU fishing

Measures can stop IUU fishing
Community surveillance
Increasing deterrence
Strengthening national-level interagency cooperation
Strengthening court systems
High but low-cost technological options
Observers to strengthen cross-checking
Traceability and labelling

Note: Adapted from The Pan-African Fisheries by NEPAD (2016)

e. New trends in MCS technology for artisanal fisheries

Modern technology is improving the way MCS is applied to artisanal fisheries worldwide including, in some way, Peru. Currently, there are many initiatives in use or in the development stage that aim to solve the problem of such fishing activities. Unfortunately, there are no indicators about their performance, yet. Table 11 shows the main components of MCS and the new technology that currently supports them.

Table 11. New trends in MCS technology for artisanal fisheries

Main MCS components	**New trends in MCS technology**							
	Electronic recorder and reporting system	Inshore-VMS	RFID	QR	Electronic monitorig-onboard cameras	Drones	Blockchain	Big data
Logbooks	**X**							
Patrol vessels						**X**		
Aerial surveillance						**X**		
Observer schemes					**X**	**X**		
VMS		**X**						**X**
Satellite imagery								
Data management and MCS coordinations		**X**						**X**
Catch monitoring	**X**		**X**	**X**	**X**		**X**	
Inspections at sea								
Transport monitoring			**X**	**X**			**X**	
Market monitoring			**X**	**X**			**X**	

Note: Adapted from A Fishery Manager´s Guidebook by FAO (2009), The EU System by European Commission (n.d.), Girard & Du Payrat by Norwegian Ministry of Trade et al. (2017), IVMS Device by UK Marine Management Organization (2024) and Goula by QR Code press (2017).

f. Specific practical examples of uses of technology for artisanal fishing

Some countries, not only developing ones, are developing projects related to MCS and new technology.

Table 12. Practical examples of uses of technology for MCS in artisanal fishing

Country/Region	Technology	Objectives	Data transmission medium	Maximum distance from coast
United Kingdom	I-VMS	Send position and vessel name	GMS/GPRS	30 Nm
Indian Ocean	Video camera	Collect fishing data	No data transmission	All zones
Peru		Record video of activities on board		
Malaysia	QR code tag	Verify identification of vessels		Less than 3 meters
Thailandia				
Indonesia				
Oceania	QR code tag	Traceability of all supply chain: from the capture of fish at sea to restaurant		No data transmission
	RFID tag	Traceability of all supply chain: from the capture of fish at sea to restaurant		No data transmission
	Blockchain	Database to register all the information		No data transmission
European Union	Drones and video camera	IUU fishing detection through stream live video	Microwaves. Could be by the Internet, in addition	Depends on configuration
Belize				
Palau				
Jamaica				
Costa Rica				

Note: Adapted from Briand et al. by International Commision for the Conservation of Atlantic Tunas (2018), Bartholomew et al. by Biological Conservation (2018), IVMS Device by UK Marine Management Organization (2024), Rosner et al. by Columbia University (2017), Toonen & Bush by Journal of Environmental Policy and Planning (2018), Proactive Vessel Registration by Pole and Line Foundation (2015), Visser & Hanich by University of Wollongong (2017), Thailand´s reform of fishing by Royal Tahi Embassy (2016) and Goula by QR Code press (2017).

g. The connection between IUU fishing and other criminal activities

International security agencies affirm that IUU fishing is ussually connected to other criminal activities such as:

Table 13. The connection between IUU fishing and other criminal activities

IUU fishing	Other criminal activities
Support to illicit networks	Piracy
	Armed insurgency
	Terrorism
Works in combination with	Tax evation
	Diamonds smuggling
	Arms smuggling
	Wildlife smuggling
	Human rights abuse
	Human trafficking

Note: Adapted from Illegal, Unreported and Unregulated Fishing by Center for Stretegic & International Studies (2017).

h. Details of IUU fishing in Peruvian artisanal fleet

Concerning the situation of Peruvian artisanal fleet and its relationship with IUU fishing, Table 14 shows the main aspects:

Table 14. Main aspects of IUU fishing in Peruvian artisanal fleet.

Roots of IUU fishing	Details	
High informality	No fishing licenses (FL)	
	No vessel registration certificate (VRC)	
Low value chain productivity	Manual and non-reliable traceability	
	No access to markets	
Low capacity of MCS	VMS	Not included most artisanal fleet
	Radars, Patrol vessels and aircrafts	No information available
	Inspectors	Difficulties due to crime and access to landing sites
		Ignorance of regulations
		Corruption
		No multisectorial cooperation

Note: Adapted from Medicina by Lima University (2014), Galarza & Kamiche by Pacific University (2015) and Experiencia de éxito by Ministry of Production (2013).

i. The connection between SDG 14, target 14.b and IUU fishing

Target 14.b of the SDG 14 is to "Provide access for small-scale artisanal fishers to marine resources and markets". For the Peruvian case, "SMART" indicators could be the ones established by PRODUCE in its Multiannual Sectorial Strategic Plan. There is also a logical connection between these indicators and the roots of IUU fishing. Table 15 shows the connection between them.

Table 15. The connection between target 14.b of SDG 14 and IUU fishing

Roots of IUU fishing	PRODUCE Indicators	Connection to target 14.b-SDG14
High informality	Percentage of formalized artisanal fishing vessels	Access to local and international market
Low value chain productivity	Percentage of economic units of artisanal fishing sector with access to financing	Access to local and international market
	Annual per capita fish comsumption cathched by artisanal vessels	Access to local and international market
Low capacity of MCS	Coverage of supervision and control of artisanal fishing activities	Access to marine resources and to local and international market

Note: Adapted from Multiannual Sectorial Strategic Plan by Ministry of Production (2017)

4.2.2 Interviews results

As mentioned above, interviews were conducted to obtain first-hand information. In total, eighteen people were interviewed. Eight fishery inspectors, seven fishers from seven OSPAs and three ICT technicians. It is important to say that all the interviews were conducted within a cordial environment and 100% of those interviewed answered all of the questions.

a. Interviews with inspectors of PRODUCE

i. Features of IUU fishing

According to the interviews, in general, IUU fishing incidents are common in all regions. However, some of them have specifics particularities. The most common IUU fishing problem in all the regions is related to vessels without FL or VRC. The other most common IUU fishing issues refers to fishing that takes place in exclusive areas for artisanal fishing by unauthorized vessels, near the coastline. For instance, small-scale fishing vessels that are fishing within three nautical miles from the coastline.

The following IUU fishing types were not mentioned by all the heads of regions. Only two or three regions mentioned them, and they are: fishing of smaller sizes or young species, fishing in MPA, fishing with unauthorized fishing gears and the cloning of vessels. A disturbing IUU fishing type mentioned is fishing with explosives in the regions of Chimbote and Lima, which destroy marine ecosystems. The type of IUU fishing least mentioned (only once) was the lack of respect for the fishing seasons of the species, also in the Lima region.

On the other hand, in all the cases, the heads of the inspectors mentioned that, usually, the illegal fishing is unloaded in unauthorized places, where the PRODUCE inspectors do not have a presence or have limited access. Some beaches and small bays, for instance. Less mentioned was transshipment and fish laundering. Finally, the inspector of Tumbes (northern country, border region) mentioned that the illegal fishing usually goes to Ecuador. However, in these cases inspectors said that they do not have evidence of that.

The region which heads mentioned that its IUU fishing incidences are minimal is the Moquegua-Tacna region.

ii. Inspections issues

The most common issue mentioned in the work of the inspectors was the lack of logistics, including vehicles, GPS and binoculars. Everyone, except the Moquegua-Tacna inspector

mentioned the low number of inspectors. Nonetheless, all the inspectors mentioned that they have more personnel now than in previous years.

In this regard, due to the lack of logistics and human resources, some mentioned that most of their illegal findings are as a result of complaints and information from the fishers themselves. In this regard, the inspector of Ancash said that capacity building for fishers is now being prioritized, concerning the importance of sustainable fishing.

All of the interviewees said that most of the inspections are in wharves, and only when they work with DICAPI, do they inspect vessels at sea. Some of them mentioned that it is important to work together in a multisectoral way because they could have better coverage and scope.

Finally, the head of the Tumbes region mentioned that they have a common issue related to security matters. Most of the time, fishing vessels owners that work illegally hire criminals to avoid controls by authority and this situation puts inspectors integrity at risk due to aggression and violence. They do not always have the support of DICAPI or the Peruvian National Police (PNP).

iii. Traceability

Regarding traceability, the interviewees mentioned they often inspect the refrigerated trucks in which the products are transported, together with PNP. The inspections are a request for the SC to the truck driver. The problem with this is that the SC is only a sworn declaration in a physical document, therefore, it is very easy to lie to the inspectors when IUU fishing has been committed. Moreover, the interviewees mentioned that they are all in permanent communication among all the regions to exchange information to check the veracity of the SC. One of the means of exchanging information to check the veracity of the SCs is through Whatsapp.

In this regard, one of the inspectors said that the average of inspections is 10% of the land vehicles transportation. So, 90% of the products are without a traceability audit. However, these products are exported anyway.

iv. SISESAT in the artisanal fleet

According to the interviews, all the inspectors have access to SISESAT through information provide by the PRODUCE monitoring center by cellular phone. When this center detects vessel possibly involved in IUU fishing, they make phone calls to the inspectors and give the information digitally. On the other hand, everytime the inspectors go to a vessel, they check the SISESAT information.

Inspectors can only use the SISESAT with the vessels that have this system and, as mentioned before, most of the artisanal fishing vessels do not have it.

In the question concerning their opinion about the use of satellite devices for the artisanal fleet, four inspectors mentioned that in the past there were many initiatives in this regard. Nevertheless, due to the high cost of the system, the artisanal fleet never complied with these kinds of regulations.

b. Interviews with fishers presidents or general secretaries of Fishing Unions

i. Formalization of their activities

Acording to the interview, all of the fishers interviewed agreed to the benefits of being formalized, especially in relation with access to credits and social assistance. Besides, they said there had been important advances in formalization, mainly due to the SIFORPA program.

However, about SIFORPA, all the answers referred corruption issues with the program despite it being a good measure for them. The main problem is the lack of control of the heads of authorities. They do not have a good procedure for verification of the vessels to be formalized nor do they have control over their personnel. For example, fishers mentioned that SIFORPA is for existing vessels, not newly built vessels and corrupt owners of ships takes advantage of the situation and negotiate with some corrupt authorities for a new VRC, therefore, a new FL. Another case occurs with false measurements of vessels. For example, the vessels that are supposedly five units of gross

ton, end up in the documents being ten units, due to arrangements over the measurements with some corrupt authorities.

Finally, some fishers mentioned that they had never been interested in formalization, due to their idiosyncrasy.

ii. SISESAT in the artisanal fleet

At this point, most of the fishers agree to have these kinds of devices and services onboard their vessels. However, due to their high cost (approximately US$ 50 monthly according to the fisher from the Moquegua-Tacna region), it is currently impossible. In this regard, the fisher from Cancas said that, in some fishing seasons, the fishers only have on average the equivalent of US$ 30 of weekly income (US$ 120 monthly[16]) for two or three months.

Moreover, the fisher from the southern country border region, Moquegua-Tacna, mentioned that despite the high cost of these devices, it would be better to pay this instead of paying the judicial processes and fees of Chilean authorities when the vessels cross the border illegally without the knowledge of the vessels owners. In this case, these devices could help avoid this situation. Nevertheless, he also mentioned that now is not currently possible to pay for it due to the high cost.

On the other hand, the only interviewed fisher who does not agree with these devices on board is a fisherman from the northern border village of the country, called Puerto Pizarro. He said that for them it is not convenient because fishers in this zone usually go fishing in Ecuador or Colombia without authorization. Therefore, they do not want the device to be detected by the authorities. He also mentioned they usually go fishing in these zones because in the northern part of Peru, there is not enough space to fish because of the geographical features and the country border configuration.

[16] In Peru, the poverty measure is related to the people capacity to buy the minimum food basket. The poverty line in 2017 was $ 101.91 US per capita and $ 407.75 for families with four members. People which per capita expense is lower than that are considered poor. Extremely poor are who not cover the value of the food basket of $ 55.26 US per capita and $ 221.04 US for a four members family (Pobreza monetaria afectó, 2018).

Finally, except for the fishers of Puerto Pizarro, All the fishers agreed to have monitoring devices if the devices are free or low cost.

iii. Traceability of their fish products

According to all the interviews, the fishers do not take charge of the traceability because usually, the buyers do it. Besides, often the buyers are the same for all the vessels in the regions. In some cases, they are the same for more than one region.

Finally, the cost of a product of legal fishing or an illegal one is the same. The important thing is the quality. That is to say, for the commercial purposes to local or international markets, the legality of the fishing does not matter.

c. Technical ICT personnel

These interviews were aimed at understanding how the transmission of the data from the vessels arrives at the monitoring centers of PRODUCE (SISESAT) and DICAPI (SIMTRAC). The three technicians interviewed mentioned that in both systems the information arrives through a TCP/IP[17] protocol.

For this study, the most critical finding is that for both systems it is possible that the information arrives from the vessels to the monitoring centers through an e-mail, under some easily configurable parameters. That is to say, it is possible to send information (name of the vessel, position, and others) to both systems through a simple e-mail message following a determined structure/format. Both systems have their cybersecurity measures and protocols. Besides, it is possible to transmit the same information in an automated way using an adequate software application, that is easy to develop.

On the other hand, the engineer from PRODUCE said that they are developing new low-cost satellite devices for artisanal fishing, in compliance with the new regulation of formalization (Decreto Legislativo N° 1392, 2018). He also mentioned that the approximate cost of these devices´ services could be between $30 US and $50 US per

[17] Set of networking protocols that allows computers to communicate.

month rather of $150 US – $200 US per month[18] for the standard devices for large-scale fishing.

Moreover, he said that the solution should be satellite instead of cell phone because the artisanal fishing, as high fishing, for instance, goes beyond the cellular coverage that extends to 40 nautical miles from the coastline.

4.2.3 Findings from questionnaires

The following information was obtained for each question:

i. Most frequent mean used by DICAPI to monitor artisanal fishing vessels

The first question is related to the perception of the respondents, based on their experience, as to which source of monitoring are most frequently used by DICAPI. Of the 22 Officers, most of them, 25%, mentioned that the most frequent means was visual observers (inspectors) rather than electronic and mobile means. 20% mentioned the coastal radars. Moreover, 20% of the officers said that the most frequent means to monitor artisanal fishing vessels is through SIMTRAC. 17.5% considered patrol vessels, and 10% respondered that monitoring is through the manual control of authorization of vessels departures (document). 5% said that the most frequent monitoring means is through radio communications and 2.5% mentioned the patrol aircraft as the most frequent.

[18] In the FAO website, about the Peruvian VMS program, they mention that the monthly cost of satellite service is $ 200 US approximately.

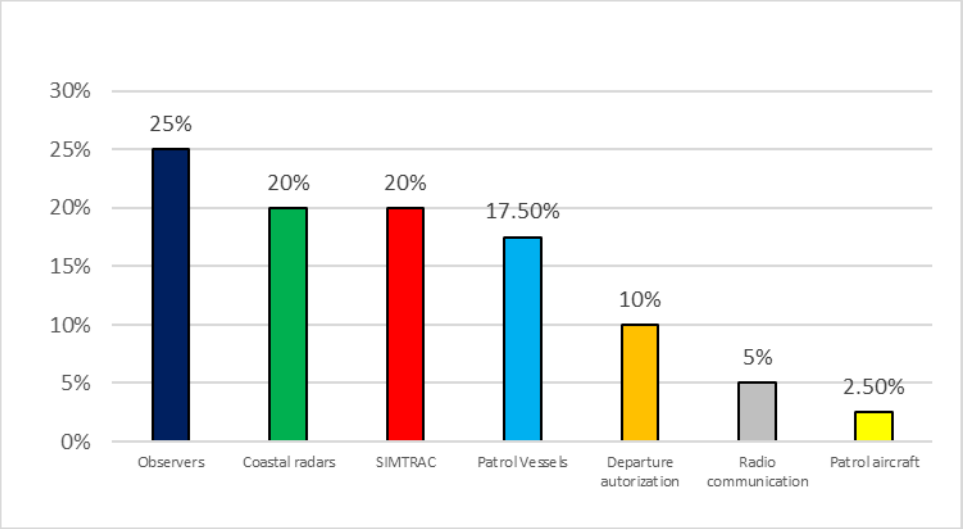

Figure 19. Most frequent mean used by DICAPI to monitor artisanal fishing vessels.

ii. Most efficient mean used by DICAPI to monitor artisanal fishing vessels

In this case, unlike the previous question, the majority (56.1%) mentioned the electronic means, in general, instead of the observers, who obtained 24.39%. Also, 14.63% think patrol vessels are the most efficient. For patrol aircraft and documenting of the departure of vessels, 2.44% of the officers for each one, think it is the most efficient.

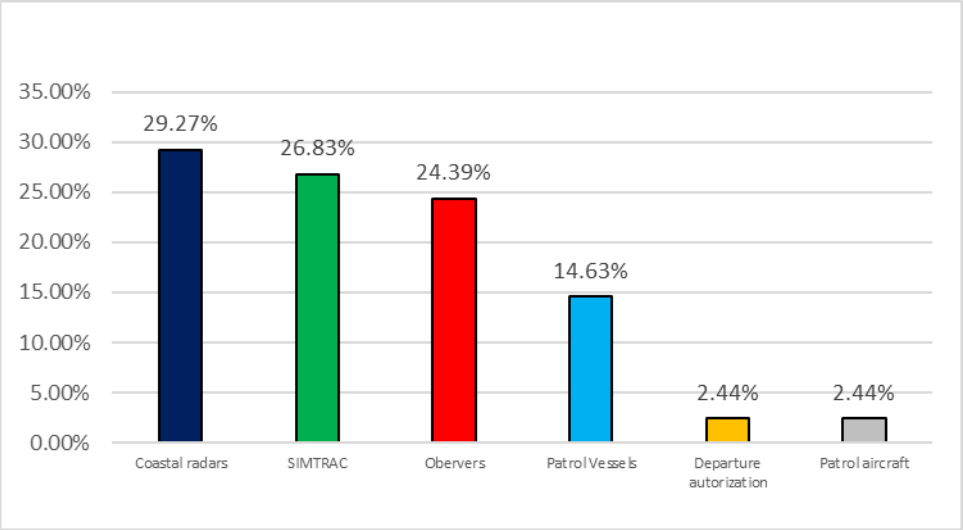

Figure 20. Most efficient mean used by DICAPI to monitor artisanal fishing vessels.

iii. Most important deficiency that reduces the efficiency of DICAPI to inspect artisanal fishing vessels

The third question relate to the perception of the most important deficiency that reduces the efficiency of the artisanal fleet inspections by DICAPI. 43.9% of the officers think the lack of logistics and human resources are the most important deficiency. 26.83% of the aswers were related to the technology. Also, 26.83% was related to the lack of ability to corroborate the identity of a vessel and 2.44% mentioned the lack of adequate regulations.

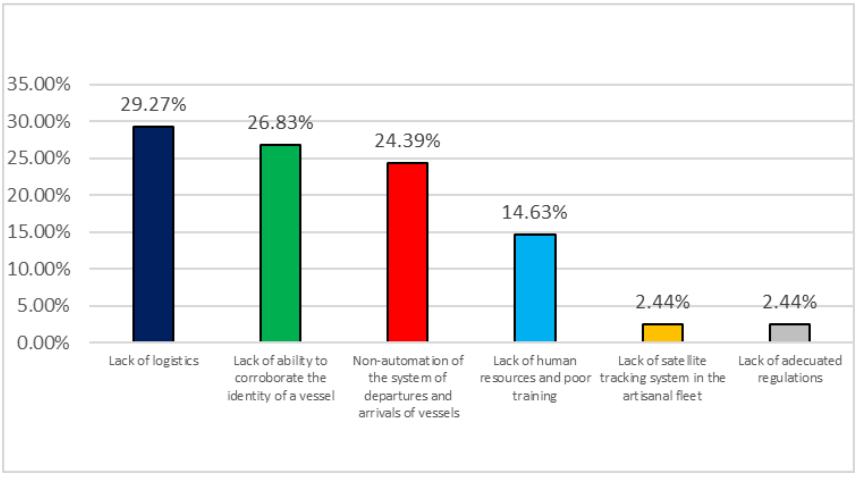

Figure 21. Most important deficiency that reduce the efficiency of DICAPI to inspect artisanal vessels

iv. Best place, wharf or sea, to efficiently inspect the artisanal fishing vessels

The fourth question is related to the perception of where is better to inspect the artisanal fishing vessels efficiently. 68.20% of the officers think it is better at the point of unloading the products (wharf) and 31.8% mentioned it is better in the fishing zone, in the sea. In this case, usually, the inspections at the point of unloading are more detailed but also take more time.

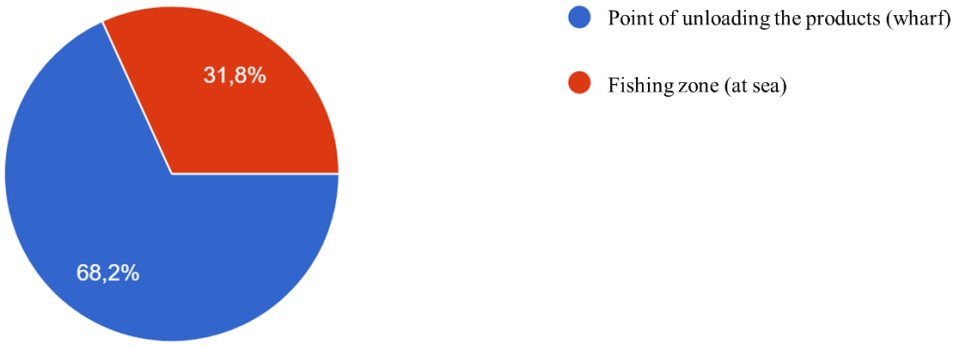

Figure 22. Best place to inspect efficiently the artisanal fishing vessels.

v. Level of importance of DICAPI having digital information of artisanal fishing vessels

This question is related to the perception of the importance of having digital, instead of physical, information related to artisanal fishing vessels, to improve the efficiency of DICAPI´s control. 95.5% of the officers mentioned that at least is important. 4.5% think it is not that important. None consider it unimportant.

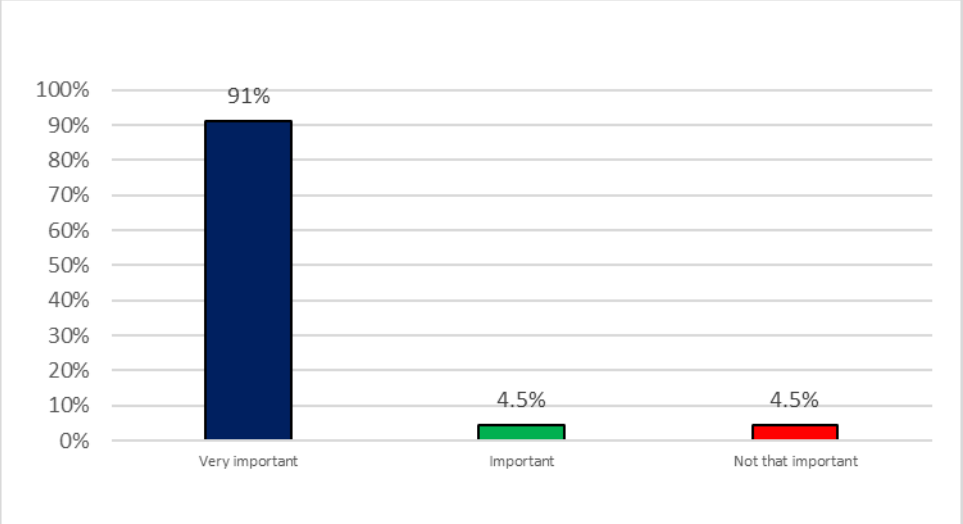

Figure 23. Level of importance for DICAPI about having digital information for artisanal fishing vessels.

vi. Level of importance for DICAPI about having automated control procedures for artisanal fishing vessels

The sixth question is related to the importance of having automated control procedures related to the artisanal fishing vessels to improve efficiency in control by DICAPI. 86.3% think it is at least important; 9.2% said it is not that important. However, 4.5% mentioned that this matter is not important.

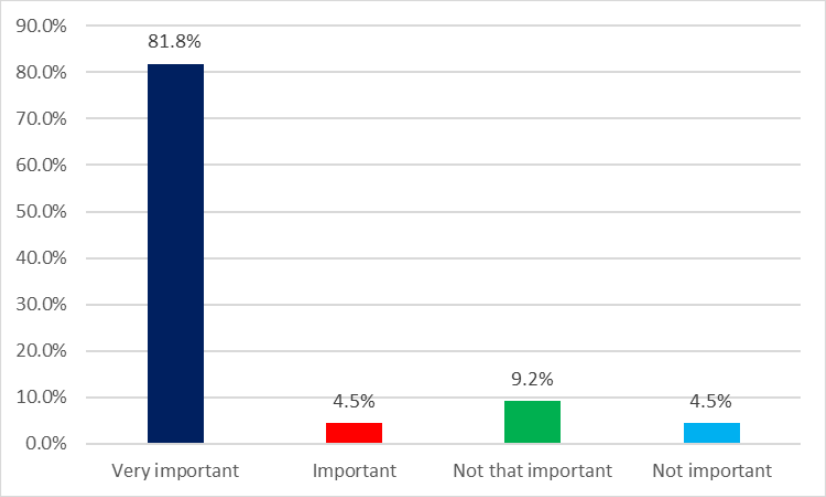

Figure 24. Level of importance for DICAPI about having automated control procedures for artisanal fishing vessels.

vii. The main reason why DICAPI does not have digital information about artisanal fishing vessels nor automated control procedures

The seventh question is related to the perception about the reason why DICAPI does not have digital information on artisanal fishing vessels nor on automated control procedures. 28.21% think the main reason for lack of digital information about the artisanal fleet and automated control procedures is the lack of decision in DICAPI. 23.07% mentioned lack of logistics from DICAPI and 20.54% said the high costs to the owners of fishing vessels. 17.94% mentioned the lack of coordination between inspectors of PRODUCE and DICAPI; 2.56% mentioned corruption in DICAPI; 2.56% said lack of engagement of vessels owners. 2.56% though technological limitations and 2.56% mentioned the lack of real information about artisanal fleet.

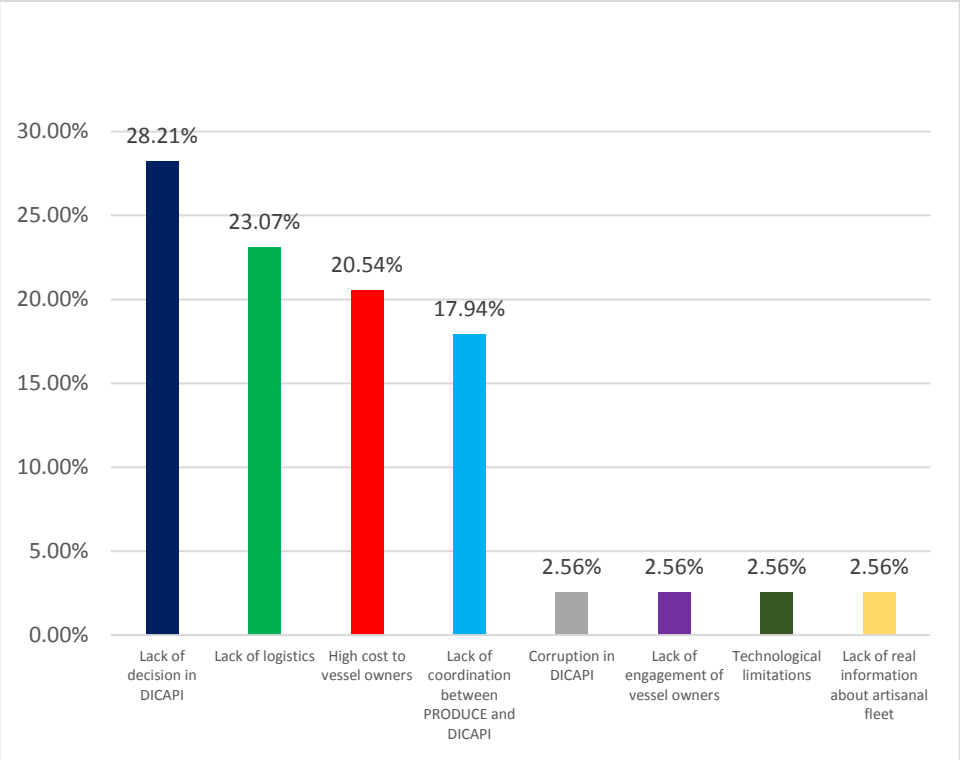

Figure 25. The main reason why DICAPI does not have digital information about artisanal fishing vessels nor automated control procedures for them

viii. The best way for DICAPI to improve efficiency over the control of artisanal fishing vessels

The eighth question is related to the perception of how DICAPI could improve its efficiency in the control of the artisanal fleet. 40% think the best way to improve the efficiency in the control of the artisanal fleet is to work on the quality of the inspections, 27.5% said to increase the interest information for inspectors about fishing vessels before inspections; 17.5% mentioned maximizing the number of vessels inspected. 7.5% said to minimize the inspections time. 5% advise the use of electronic means, and 2.5% recommend that decentralizing inspections with personnel outside the captaincies.

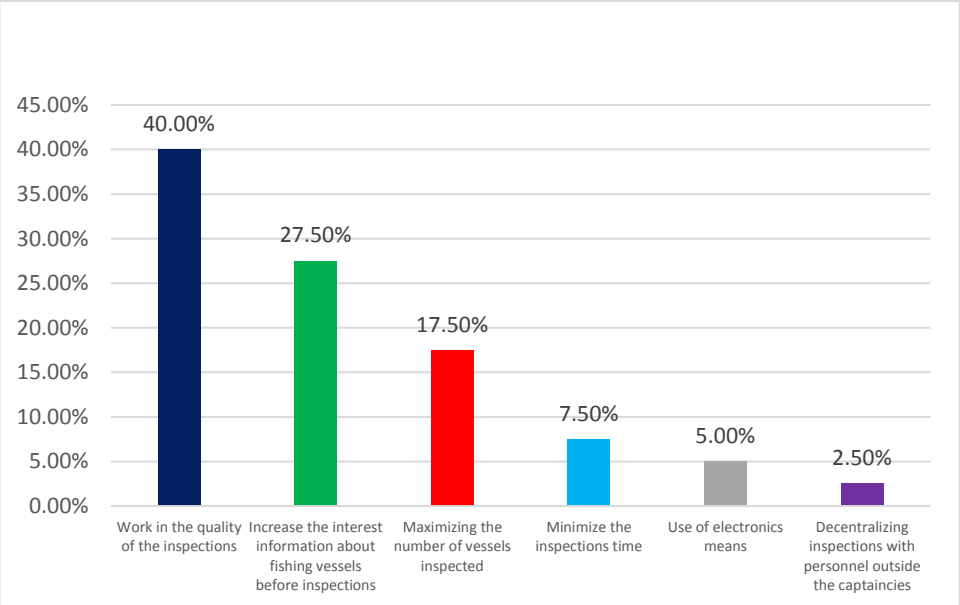

Figure 26. The best way for DICAPI to improve efficiency over the control of artisanal fishing vessels.

ix. Types of navigation information record for artisanal fishing vessels of DICAPI

The ninth question is related to identifying the perception about the way in which DICAPI registers the navigation, position and fishing zones of the artisanal fishing vessels. As there are no homogeneous answers, it can be inferred that in the practice this information is not important or maybe is not supervised. Another possibility is that DICAPI does not have common nor clear procedures.

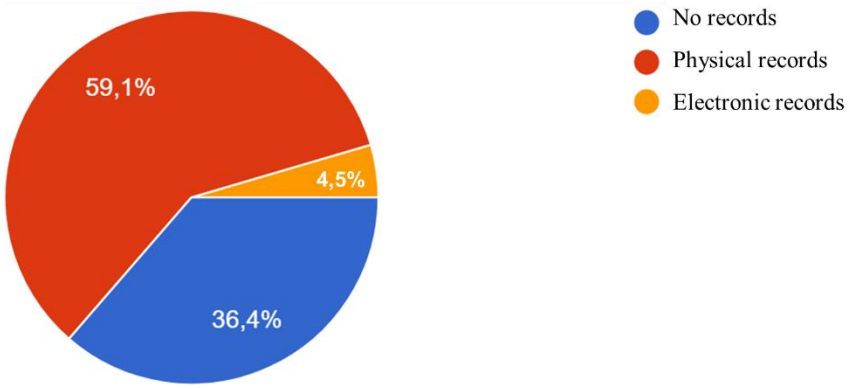

Figure 27. Types of navigation information record for artisanal fishing vessels, of DICAPI.

x. Level of importance of DICAPI having at register of navigation information

The tenth question is about the perception of the importance for DICAPI to record the navigation, position and fishing zones of the artisanal fishing vessels. About this, 95.5% said at least it is important while 4.5% think is not that important. None consider it no important.

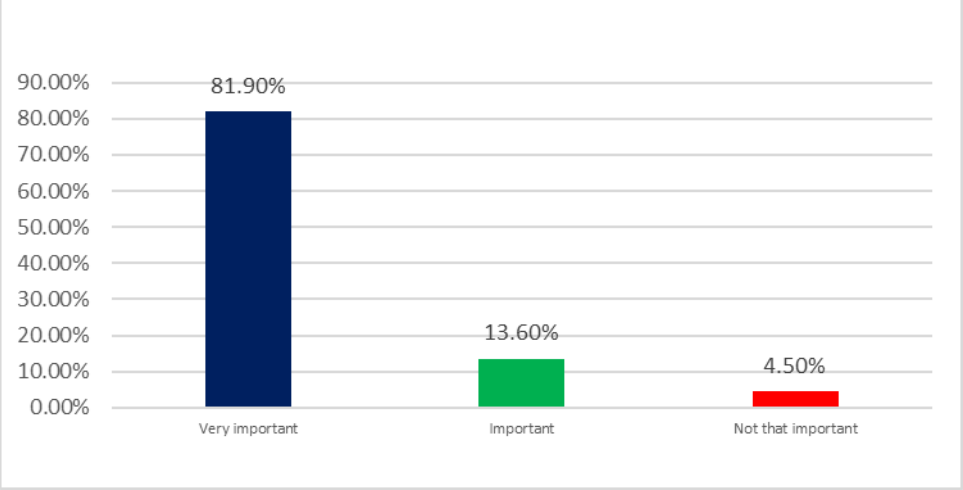

Figure 28. Level of importance for DICAPI about having the register of navigation information.

xi. Level of engagement of artisanal fishing vessels in illegal activities apart of IUU fishing

The eleventh question regards the perception of the officers about whether some artisanal fishing vessels being involved in illegal activities apart IUU fishing. 86.4% of the officers think that at least some could be involved and 13.6% think some are less involved.

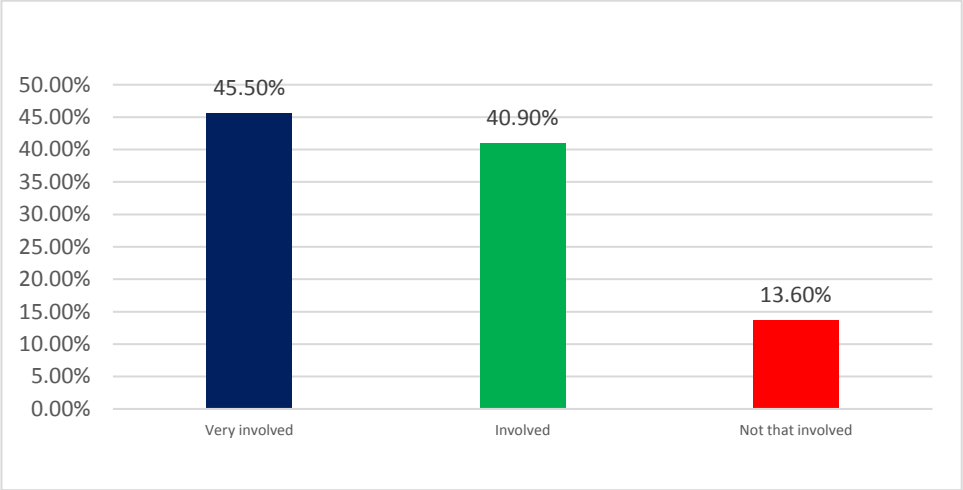

Figure 29. Level of engagement of artisanal fishing vessels in illegal activities apart of IUU fishing.

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xii. Types of illegal activities that artisanal fishing vessels could be involved

The twelveth question is about the perception of what kind of illegal activities some artisanal fishing vessels could be involved in. In this case, half of the officers think some could be involved in illicit drug trafficking. 31.58% said some of them in fuel smuggling; 10.53% mentioned that some fishing vessels in pollution and 7.89% said some in theft, in a general sense.

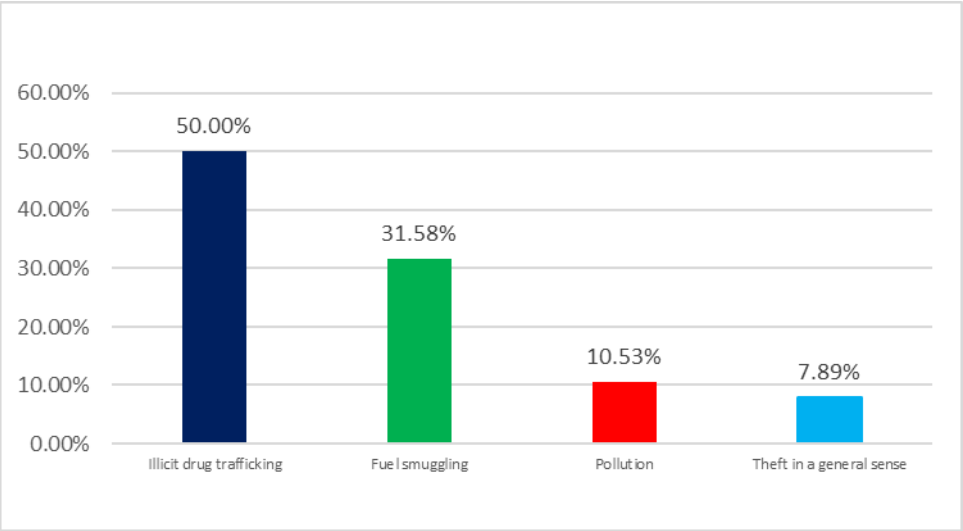

Figure 30. Types of illegal activities that artisanal fishing vessels could be involved.

xiii. The inclusion of artisanal fishing vessels into SIMTRAC domain

The thirteenth question is about the employment of SIMTRAC to monitor artisanal fishing vessels. 95.5% of the officers think artisanal fishing vessels should be monitored by SIMTRAC, while 4.5% of them think they should not.

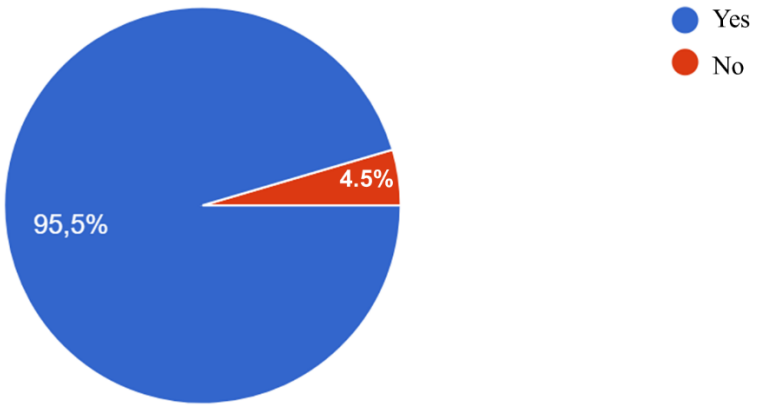

Figure 31. Opinion about the inclusion of artisanal fishing vessels into SIMTRAC domain

4.3 Triangulation among methods

Triangulation is a methodologic procedure that consists of contrasting the results through the comparison of resources and tools used to increase the reliability of the data (Glesne & Peshkin as cited by Pomposo, 2015). However, "it is not aimed merely at validation but at deepening and widening one's understanding, tending to support interdisciplinary research rather than a strongly bounded discipline of sociology (Olsen, 2004)".

In this regard, triangulation was used in the present study to obtain the best information for the search for a new design of MCS system that could be suitable for artisanal fishing in Peru, as a result of the qualitative content analysis, interviews and questionnaires. Therefore, after analyzing the data obtained from those methods, the results found are shown.

The results obtained from the interviews and questionnaries confirm the information gotten from the content analysis, in a general sense. However, through the primary source material, much more data was obtained.

As a result, the study shows that the general cause of IUU fishing concerning Peruvian artisanal fisheries is the lack of an efficient MCS due to inadequate logistic and human resources of the authorities, which when added to the low productivity of the value chain in the sector brings high informality to it. In the same way, high informality is strongly connected with the lack of access to both marine resources, due to overfishing and strong competence (for instance, the increase of the fishing fleet due to informality or large-scale vessels fishing in exclusive areas for artisanal vessels), and markets for artisanal fishers who fish informally.

To combat the informality, PRODUCE has been implementing important formalization programs. Nonetheless, according to the opinion of the fishers, the corruption and lack of control measures by authorities does not allow a real positive impact in the sector. As an example, one fisher claimed. "Now, with the official formalization programs, there are too many artisanal vessels for few fish. Many such vessels never existed before these programs" (personal communication, August 2018).

Consequently, most of the high informality incidences are related to lack of FL and VRC of the vessels. This situation allows them to fish in unauthorized zones, fish in MPA, fish smaller sizes of fish, to clone of vessels or to fish with explosives. Moreover, one way to unload the illegal products is through fish laundering, which is transshipping the fish from illegal vessels to legal ones. Another way of fish laundering could be adulterating the SC, so that registered fish products from illegal vessels would pass as legal ones, but just on paper. On the other hand, probably the most common way is unloading the fishing through unauthorized points of discharge (ports of convenience), such as beaches and small bays, where there are no inspectors due to, again, lack of logistics and human resources.

Regarding MCS measures for artisanal fishing, PRODUCE employs approaches recommended by FAO, which are inspectors that receive information and complaints from the fishers and community. In this regard, inspectors mentioned that for this work it is preferable to inspect the vessels in the fishing zone, to have all the details of the fishing activity. Likewise, one way to improve their inspections is to increase the joint work with other institutions such as DICAPI or the PNP.

An important point is the security issue, concerning the risk to the inspectors due to aggression and violence against them in the Tumbes region because of the hiring of criminals by owners of fishing vessels, to "protect them" against the inspectors' work.

Likewise, PRODUCE is trying to employ the SISESAT for this kind of fishery, so far with negative results due to the high cost of satellite services that the fishers are not willing to pay for, even though in most cases, they recognize that these devices are good solutions for them.

On the other hand, DICAPI has more resources than PRODUCE in relation to MCS, including patrol vessels and aircraft, and coastal radars, inspectors and the SIMTRAC. These three last sources are the most efficient of all, according to DICAPI officers. However, in the case of SIMTRAC, it occurs the same as SISESAT; the high cost of services does not allow their implementation in the artisanal fleet. Also, the lack of logistics does not allow an efficient MCS.

In this sense, contrary to PRODUCE inspectors think, most of the DICAPI officers said it is better to inspect the vessels in wharf rather than at sea. Likewise, most of these inspectors think that a better way to improve inspections is by having digital information on the vessels, including the registration of navigation information like routes and fishing zones as well as having automated control procedures. They also think it is very important to include artisanal fishing vessels into the SIMTRAC. However, they also think that DICAPI does not have these kinds of tools due to lack of logistics that can be translated as a lack of real decision. Another way that DICAPI inspectors think is possible to improve the efficiency of MCS is to work on the quality of the inspections as well as increasing the information of the vessels before implementing a control measure, that is, to have a better judgement and identification of the targets.

Regarding traceability, the only source that PRODUCE has is the checking of the SC document manually, but their capacity to monitor it through the control of land vehicles is feeble. Additionally, the fishers do not have incentives for traceability, so they are not interested in it, since the selling price of the fishing products, whether legally or illegally fished is the same. That is to say, it does not matter if the fishing is illegal or not, thery are goint to sell the product at the same price, anyway.

In reference the new trends in MCS technology, there are many projects worldwide especially for artisanal fishing that include electronic recording and reporting system: I-VMS, RFID, QR codes, onboard video cameras, drones, the blockchain, and big data. All of them have been developed to solve the high- costs problems of satellite systems and traceability. In the same way, in Peru, PRODUCE is also developing a new low-cost satellite system for artisanal fishing. Nonetheless, there is no news about improving traceability.

An important issue, according to the opinion of DICAPI officers, is that a lot of artisanal fishing vessels are engaged in illegal activities apart IUU fishing, such as illegal drug trafficking and fuel smuggling. This information is related to the information obtained from the content analysis that argues that IUU fishing is usually connected with other types of criminal activities.

Finally, regarding SDG 14, goal 14.b: "Give access to small-scale artisanal fishermen to marine resources and markets" and their compliance in Peru. The fulfillment of this

objective goes hand in hand not only with the formalization of artisanal fishing but also with an efficient MCS and value chain productivity. If the Peruvian artisanal fishing would have most of its vessels formalized, the value chain woulds be more productive, and the fishers would have more access to local and international markets. Likewise, if they are formalized, there is goinf to be fewer risk to marine ecosystems, so, fishers would have more access to marine resources. Therefore, if they are adequately involved in an efficient MCS, they are going to be forced into formalization. Consequently, they will have access to marine resources and, also, markets.

In other words, the more formalized artisanal fishing, the more access fishers will have to resources and markets. Such formalization is achieved mainly due to an efficient MCS. In this regards, the PRODUCE indicators in its Multiannual Sectoral Strategic Plan are sufficiently "SMART" to measure both, the yields of MCS and the objective 14.b.

To help in the design of an efficient MCS system suitable for artisanal fishing in Peru, Figure 32 summarizes the findings in the triangulation.

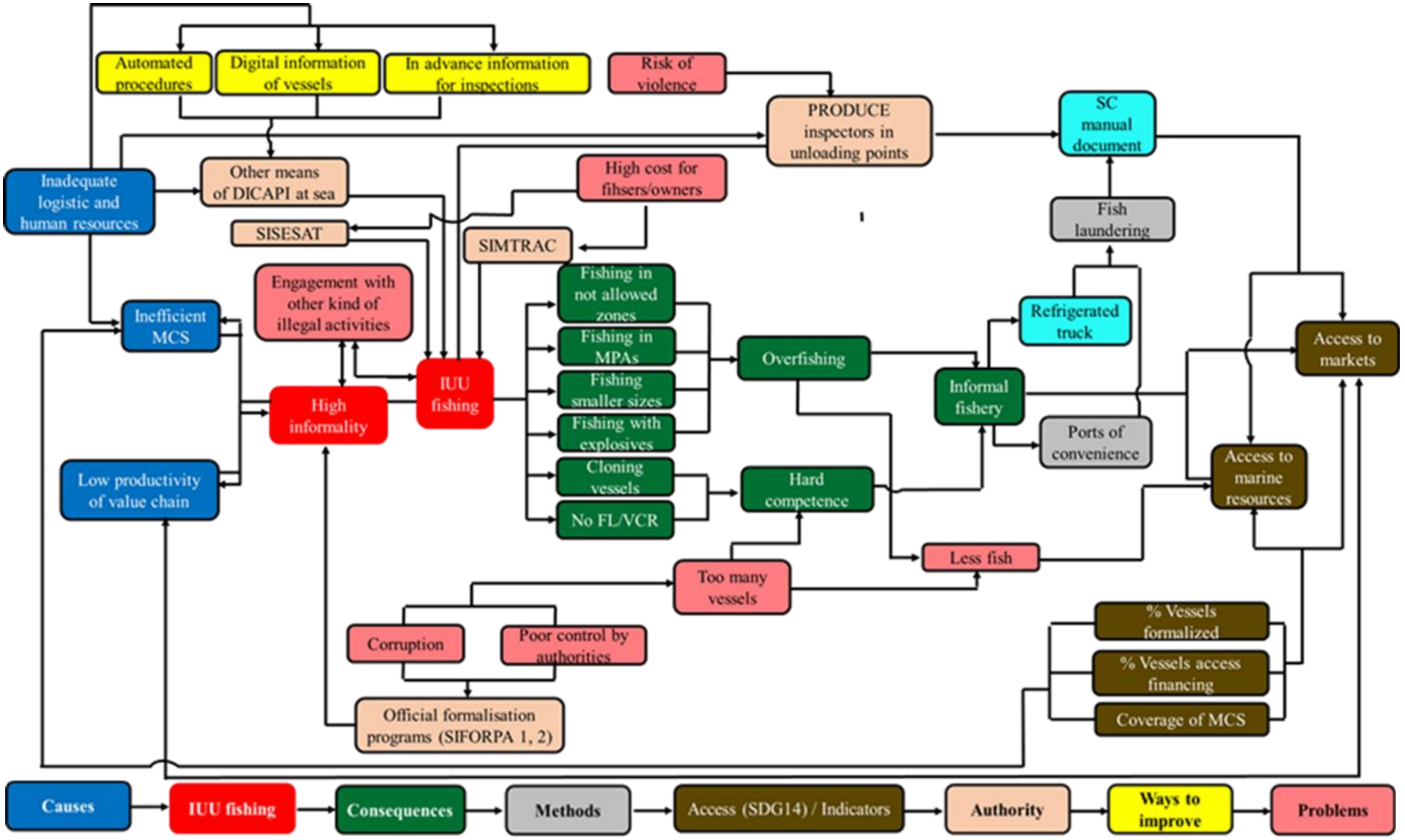

Figure 32. Conceptual map of the summary of the findings of triangulation among methods

5 NEW MCS DESIGN SUITABLE FOR ARTISANAL FISHING IN PERU

5.1 Making decisions about deisgn alternatives

To aid the design of a new MCS system suitable for Peruvian artisanal fishing, the multi-criteria decision-making (MCDM) scientific method, a discrete[19] one, from the operation research discipline will be used (Wilkes as cited by Asadpoor, Ghayomi, Majlesi, Shakoori, Ahmadzadeh, Mahmoudzadeh, 2013). This kind of method, "far to be considered infallible and accurate element, which use allow to find an optimal and definitive solution, is a base, supported by scientific elements, which bring distinctive improvements to make a decision" (Berumen & Llamazares, 2007).

In this sense, considering the cases of other countries that are working on similar projects as the one in the present study, our MCS design should cover most of the IUU fishing issues, MCS and the conditions of Peruvian artisanal fishing previously analyzed.

To that end, the Scoring method will be employed (Casañ, 2013). In the decisional matrix in the application of this method, the decision criteria correspond to the main features or issues of IUU fishing, and artisanal fishing in Peru, analyzed before, in the triangulation among methods. Likewise, the set of alternatives in the matrix will be the different technologies that some countries are developing in relation to the MCS of artisanal fishing, analyzed in chapter 4 of the present study, with the method of qualitative content analysis.

In the case of the criteria ponderation, the weights were assigned from 1 to 10, considering subjective criteria, regarding the efficiency, importance, frequency, and duplication with

[19] When the number of decision alternatives is finite.

current similar systems and measures of MCS in Peru. For this case, the subjectivity is based on the author´s own experience in Coast Guard operations and on the knowledge acquired through the present study. Also, the punctuation for each alternative will be subjective from 1 to 4. The results of the matrix are showing in Table 16.

Table 16. Results of the decision-making matrix.

Decision criteria	Weight	Set of alternatives					
		I-VMS	Video camera	QR code tag	RFID tag	Block chain	Drones and video camera
Low cost	10	2	1	4	3	1	2
Help combat other illegal activities	9	2	2	2	2	1	4
In advance information for inspections	8	3	1	3	3	1	4
Compatible SISESAT/SIMTRAC	8	4	4	2	2	1	3
Traceability through supply chain	8	2	1	4	4	3	1
Automated procedures	7	4	1	4	4	2	1
Digital information of vessels	7	4	1	4	4	2	1
Combat fish laundering	7	1	4	1	1	1	4
Control ports of convenience	6	4	2	2	2	1	4
Risk of violence inspectors	5	1	3	1	1	1	4
Replace other means MCS (patrol vessels, aircraft)	5	2	1	2	2	1	3
Complement other means MCS	4	3	3	2	2	1	3
Help lack of human resources	4	2	2	3	3	2	3
Corruption	3	1	3	2	2	2	4
Total		**235**	**179**	**246**	**236**	**128**	**257**

Note: Own elaboration (2018).

The result of the decision-making matrix shows that drones equipped with cameras could fulfil, in a better way, the MCS task for artisanal fishing, instead of other technologies. Also, drones have a relatively low cost, depending on their configuration and sensors. Despite QR codes and RFID tags being much cheaper, drones' capacities make them more efficient[20].

This point, the cost, is crucial, considering that the artisanal fishers will not pay for a monthly service. In this regard, the new satellite service proposal of PRODUCE would lower its cost from approximately $ 200 US to between 30 $ US – 50 $ US per month for artisanal fishing, according to the interview with the ICT engineer of PRODUCE.

[20] Through a quick search in the internet we find that a monthly plan for a professional QR code is about $ 40.00 US (there are some free of charge), a passive RFID tag is about $ 0.20 US, an active RFID tag is roughly $ 25.00 US, a 20 meters long-range RFID reader is about $ 500 US, a short-range one is about $ 120 US, a commercial drone with 25 minutes of fly autonomy is about $ 1,000.00 US and a thermal vision camera for drones is roughly $ 4,900.00 US.

However, from my point of view, this new proposal would fall on a broken sack, again. As the fisher of San José said in the interview, there are some months when they only make an income of roughly $ 30 US per week.

On the other hand, the next technologies in the decision matrix were QR codes and RFID tags which differ only in the cost since QR codes tag are much cheaper. These technologies have the advantage of being perfect for traceability of the whole supply chain due to their sizes, that can be fixed on the fishing products. Also, their features allow them to automatize the procedures of inspections through the QR/RFID and the digital information of the vessels in their systems.

The limitations of such technologies are that they can only be used for the traceability or control in verifying documents of ships or fishers.

The next technology is the I-VMS, which is also low cost compared with satellite services. They can track the vessels, automatize procedures, have digital information of them and are compatible with SISESAT and SIMTRAC through e-mail. Neverless, they only work whitin cell phone coverage, which is no more than thirty kilometers from the coastline.

About the video cameras, their main disadvantages are their cost and that they can not transmit real time information.

In Peru, there are some small vessels, not fishing vessels, that have on board small AIS devices. It could be a solution, but also this equipment is expensive for artisanal fisheries and has the problem of the coverage of VHF that also is until thirty kilometers from the coastline.

In this sense, one option could be the development of an app and device that could work together with the communications equipment on board in combination with GPS. The developed application and device could extract the GPS coordinates automatically and send them by VHF or other communication equipment. However, again the problem would be the coverage. Also, for this solution, somebody would have to manipulate the GPS and the communication equipment to open, dismantle and connect the developed device to it, to extract the data and send it.

Finally, blockchain technology, as it is a kind of database, could work perfectly in combination with any of the solutions presented.

5.2 The new design

After all the research, the best solution for the design of a new MCS system suitable for artisanal fishing in Peru would be a combination among more than one of the technologies. According to the analysis, the most suitable solution is which include drones and QR code tags as a system, in an integrated way. However, they could operate also, in an independent way and integrate as necessary.

Then, depending on the results, it is possible to move to RFID tags instead of QR codes and to include I-VMS as a complement.

Nevertheless, regardless if the project goes from one stage to another, a very important part for the success of the project is the integration with the existing systems and the multisectoral and cooperative approach in the field work.

5.3 Discussion

The combination of drones and QR codes could cover many aspects of artisanal fishing issues, including high informality, IUU fishing and acess to the marine resources and markets for the artisanal fishers. As seen in the present study, these problems are connected, so there is one combined solution for three main problems.

In this sense, for the development of the project, QR codes tags must be assigned to the artisanal fishing vessels with the most relevant information, name and number of certificates, for instance. This information should be supported in a digital database with access to be read by QR codes readers. Blockchain technology could be a cyber-secure way to maintain such database.

The QR codes tags should improve the quality of inspections from both authorities, DICAPI from the sea on board patrol vessels and PRODUCE from unloading points of

fishing as well as in joint operations between them. With the reading of the QR tag, it could be saved time during the inspection. Therefore, it would be possible to inspect more vessels. Also, with this technology, the authorities could have an automated procedure of access to the vessels' information instead of physical and insecure documentation. It is also important against corruption

In regard to traceability, the QR tags could be used for the inspection of the vessels in the unloading points. The inspectors could generate electronic certificates of traceability and labels from the reading of the QR tags in the vessels which could be used to the next stages of the supply chain instead of the current unsecured and alterable sworn declarations.

This procedure would serve to provide access to markets to artisanal fishers. However, it would only be the beginning. These solutions should be part of a bigger one that includes sanctions on illegal fish sellers and prohibiting them to trade in these products. Also, the legal fishers that demonstrate the traceability of their products should have some incentive or benefit.

On the other hand, drones can see from the sky and have much better situational awareness than the vision from an inspector on a pier or a patrol vessel. Besides, they can fly over the vessels to check for fish laundering and ports of convenience through their capacity to see from the sky, get GPS coordinates and stream live video or picture. Likewise, to extpand the scope of the coastal and on board radars that visualize radar contacts of suspicious ships, authorities could send the drones to identify them and having more accurate information in advance for make decisions.

Regarding compatibility with the SISESAT and SIMTRAC, the drones could send the GPS coordinates of the vessels through e-mail, in a manually or in an automatized way, and integrate this information into both systems, so it would be possible to see the position of the ships in the SIMTRAC or SISEAT screens. At this point, GPS coordinates of vessels would not be other than the GPS coordinates of the drones would fly above or next to the vessels, close to them. However, rather than permanent tracking of vessels as in the satellite devices, with this new system, the tracking would be temporary when needed but also digitally recordable. Another difference with the satellite tracking is that

by this mean the tracking is programmed to send the data every certain and previously determined time. In the new design the tracking is up to the user.

It is important to mention that, according to the mentioned by one of the ICT engineers in the interview, the company that provides the service to SISESAT and SIMTRAC and is the owner of their interface platform, asked for permission to integrate or develop new applications and solutions that could include a fee.

Drone capacity would also allow authorities to gather information of interest about the vessels before inspection. Thus, inspectors could choose better targets for such inspections or, if it is the case, avoid vessels or wharves that have violent people who prevent the work of the inspectors. In this regard and in a general sense, it is important that drones have night vission or infra red capacity.

Another important point, in reference to transparency and the community-based approach to participatory management, is that drones could share their information with civil society through a mobile software application to any user or through international tools like Global Fishing Watch, for instance. Moreover, the information could be shared with other agencies to achieve adequate cooperation and to get evidence about their operations. This capacity is also an important tool against corruption.

Regarding costs, as mentioned, they are free of charge for fishers. Since, from the point of view of the authorities, drones could minimize patrols by vessels or aircraft becasue "they are cost effective, and it would cut down on fuel costs" (Ramos, 2014). In this way, it would help to alleviate, somewhat, the problem of lack of logistics.

On the other hand, drone limitations are related to their autonomy, and the sensors installed. Commercial drones usually have, on average, a range of operation from their controller of just five kilometres. Another thing is that the data sent goes only to the controller through microwaves. If someone wants to share this data with other users in real time, it is necessary to do it by some transmission medium. It could be the internet, but in the sea, it has the limitation of the cell phone coverage. An option for this would be to work from onboard patrol vessels to extend the operation area of drones. Moreover, if the patrol vessels had internet, they could share their information in real time everywhere. Another option is satellite services, but they would increase the cost.

On the contrary to QR codes, drones cannot have automated vessel control procedures for help too much in terms of traceability. However, if drones worked jointly with QR tags, authorities could have a powerful tool of MCS. For example, instead of inspecting the boats one by one with just a QR reader and with the time it takes to board and disembark, a drone could fly to them and read the QR tag in a faster way.

Is the same way, it would be possible to apply this new design of MCS to vessels engaged in other illegal activities like illicit drug trafficking or fuel smuggling. With this integrated technology, it is possible to improve the security and also safety issues regarding small informal vessels. In the case of safety, drones have a great potential to assist in an emergency situation on board, fire for example, as well as in a sea pollution event.

About traceability with drones, they could take a record of a vessel fishing in a determined zone, and send the data to the controller. This person, through an adequate software application could generate electronic certificates of traceability from the sea towards the end of the supply chain.

The integrated work of a drone and QR tags could be powerful tools to fight against the high informality in the artisanal fishing sector and, hence, against IUU fishing in artisanal fishing. If these conditions are reduced, artisanal fishers will improve their access to marine resources. If the new MCS design could increase the productivity of the value chain through traceability, artisanal fishers will improve their access to markets pursuant to target 14.b, SDG 14. Furthermore, to have a good way to measure the performance of drones and QR tags in these matters, the indicators of PRODUCE, in its strategic plan, would be a good way to do it.

Finally, as a way to test theoretically the effectiveness of the new design, we take the findings of the study of the New Partnership for Africa´s Development (The Pan-African Fisheries, 2016) to demonstrate the efficiency of the system. As we can see in Table 17, all the measures to stop IUU fishing in the study and also about the low productivity of value chain issue can achieve by the employment of drones and QR codes.

Table 17. Theoretical effectiveness test for drones and QR codes

Measures can stop IUU fishing	Possibilities of drones and QR codes	Artisanal fishing issues
Community surveillance	The information can be shared with civil society and community	IUU fishing
Increasing deterrence	If fishers see the drones flying near their vessels, they will know they being controlled	
Strengthening national-level interagency cooperation	The information can be shared with other agencies	
Strengthening court systems	The data can be used as evidence to support the court decisions	
High but low-cost technological options	Cutting-edge technology at low-cost	
Observers to strengthen cross-checking	Drones can observe at sea	
Traceability and labelling	Traceability and labelling are important parts of the system	Low productivity of value chain

Note: Own elaboration (2018).

6 CONCLUSIONS

The present study aimed to design a new monitoring, control and surveillance component that is suitable for Peruvian artisanal fishing. The most innovative element suggested is the use of QR codes, which have never been suggested and investigated before. Specifically, the research aimed to assess for the very first time the deployment of drones and QR codes in an integrative and holistic way, as the new MCS component to artisanal fishing vessels. Moreover, this new design could reduce IUU fishing and provide access to marine resources and markets to artisanal fishers in fulfilment of SDG 14, target 14.b.

To obtain the necessary data, qualitative and quantitative methods were used. Through the qualitative content analysis, the data from the theoretical review was analyzed toward a better understanding of the main issues pertaining to IUU fishing, artisanal fishing, MCS and SDG 14, target 14.b. From that, inferences showed that the poor control of the Peruvian fishing authorities, meaning poor MCS, allows a high informality in the sector with consequences evidenced in diverse forms of IUU fishing that foster reduced access to marine resources and markets to the artisanal fishers. This research also explored new worldwide MCS trends in the artisanal fishing focused on newly available technologies.

Moreover, new data were obtained through interviews and questionnaires. The interviews were conducted with expert fishing inspectors of the Ministry of Production and also with fishers that are currently Presidents and General Secretaries of important Fishing Unions in Peru. Likewise, the questionnaires were directed to Coast Guard experts that have many years of experience not only in MCS of fishing vessels but also in administrative positions related to issuing of certificates for fishing vessels, for instance.

The data obtained via interviews reflected the participants´ own experience, knowledge and personal opinions about the management of the artisanal fleet, IUU fishing and MCS

in Peru. Importantly, this research revealed the opinion of the primary source, the voice of the artisanal fishers who are usually less represented. Important data was obtained, such as the logistics and human resources limitations of fishing authorities, along with the very low incomes of the artisanal fishers. Besides, the interviews with the technicians in ICT from PRODUCE and DICAPI allowed the understanding of the flexibility of the SISESAT and SIMTRAC to receive data from other sources that could be explored for new low-cost projects.

After obtaining these partial results, a process of triangulation among the data from the three methods allowed the integration of the information and the deepening of knowledge in the relevant field. This new result served to make the decision and determine the best alternative possible for the design of the new component of MCS, through the multi-criteria decision-making methodology, which finally was the use of drones and QR codes in an integrated way.

The research demonstrated that the such new design as new components of MCS, could enhance the fight against IUU fishing and provide access to marine resources and the market for artisanal fishers. While it is true that such technologies are being used in other regions separately, they have not yet been developed in an integrated manner, as in the present work. Probably this study, in a general sense, is one of the firsts regarding that integration.

On the other hand, the study also demonstrated that the combined use of drones and QR codes could improve the security and safety issues regarding informal small vessels and can integrate the information of them in the current Peruvian vessels tracking and monitoring systems or even in the vessel traffic services (VTS).

Finally, through the employment of the methodologies chosen, it was possible to fulfil all the objectives of the research, which can be evidenced throughout all the chapters of the dissertation.

It is important to mention that for the implementation of the new MCS component, future research focusing on the application and experimentation of the new design is necessary.

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APPENDICES

Appendix – 1: PRODUCE inspectors interview

1. How do you inspect and audit the artisanal fishing vessels? In what places, on wharves or in the sea? Do you ask for any documentation? Measure the sizes of the products? Is it a random audit? How do you verify where the capture took place? About how many boats do you inspect per day?

2. How do you corroborate that the documentation is real?

3. Does SISESAT play an important role in auditing?

4. What faults are the most common?

5. What happens when you check that either the boat or the fisherman does not have any documentation? If the vessel does not have fishing permit? And if they have a fault? What is done with illegal fishing?

6. In theory, if fishing vessels do not have documentation in order, Can fishers sell the products? Is there any control to illegal sale? Is there any rule that requires buyers to verify that sellers have fishing permits? I myself have seen boats without permits sell their products and are even exported ... Is that IUU fishing?

7. In the case of anchovy fishing, there is already the norm of being part of the SISESAT. Will it be a simple process?

8. Do you think that all artisanal vessels should be part of the SISESAT? What would be the main problem of that type of vessels? More than money, do you think it would be that they don not want to be controlled?

9. Do you want to comment anything?

Appendix – 2: OSPA fishers insterview

1. What is your position in the OSPA?

2. How many fishers does your OSPA have?

3. What do you think about the formalization facilities of SIFORPA? What does it need to improve?

4. Do you think there is a benefit to being formalized?

5. What do you think about the proposal to install a satellite system in your vessels? What is the main cause of the non-installation?

6. If it were a low-cost system, would you be willing to provide easiness for its installation?

7. When your vessel is not in order, Do you receive less money for the sale of your marine product?

8. Do you think that if you install a satellite beacon on board your vessel, will it bring you any benefit?

Appendix – 3: Interview with ICT technicians of SIMTRAC and SISESAT

1. Is the transmission of data from the ship to the monitoring center via TCP/IP protocols, over the satellite?

2. Within those protocols, can the information be sent through an email with a determined format or structure and be accepted by the system?

3. Is it possible to send the information through the email automatically or only manual? If it is possible to be automated, are these software applications easy to develop?

4. Is it possible, as a test, to send a simulated data of a fictitious vessel (name and position) to the system from my email?

5. Quién es la empresa proveedora del sistema?

6. What new developments about electronic monitoring and tracking are doing PRODUCE for artisanal fishing? How much could them cost? Do you have an estimated date which these devices are going to be working?

Appendix – 4: Questionnaires to coast guard officers from DICAPI

I. What are the most frequent means of monitoring artisanal fishing vessels by the National Maritime Authority?

a. SIMTRAC
b. Coastal radar
c. Surface radar
d. Aircraft
e. Visual (oberver)
f. Write other

II. What are the most efficient means of monitoring artisanal fishing vessels by the National Maritime Authority?

a. SIMTRAC
b. Coastal radar
c. Surface radar
d. Aircraft
e. Visual (oberver)
f. Write other

III. Mentions an important difference that in his opinion reduces the efficiency in the inspections of the artisanal fishing vessel fleet, by the National Maritime Authority

IV. In order for the National Maritime Authority to be able to make artisanal fishing vessel inspections more efficient, where is it better to do it?

a. Point of unloading
b. Fishing zone (at sea)

V. Do you think that, instead of having physical information, it would be important for a more efficient control and intervention, that the National Maritime Authority have digitized the information related to the artisanal fishing vessels?

1. Not important
2. Not that important
3. Important
4. Very important

VI. Do you think that, instead of having manual procedures, it would be important for a more efficient control and intervention of the artisanal fishing vessels, that the National Maritime Authority has electronic control procedures?

1. Not important
2. Not that important
3. Important
4. Very important

VII. What do you think is the most important limitation so that the National Maritime Authority does not have information from the artisanal fishing vessels nor digital form or with electronic control processes?

a. Lack of logistics
b. High cost for owners of the fishing vessesls
c. Lack of decision of DICAPI
d. Technical limitations
e. Write other

VIII. How do you think it could improve efficiency in the control of the artisanal fishing vessels fleet?

a. Increase the interest information about the vessels before the inspection
b. Reduce inspections time
c. Increase the number of inspections
d. Improve the quality of the inspections
e. Write other

IX. Currently what type of registry does the National Maritime Authority have about the navigation, position and fishing zones of the artisanal fishing vessels?

a. There is no record
b. Physical, manual record
c. Electronic record

X. Do you think it is important for the National Maritime Authority to record the navigation, position and fishing zones of the artisanal fishing vessels?

1. Not important
2. Not that important
3. Important
4. Very important

XI. Do you think that some artisanal fishing vessels could be involved in other illegal activities other than IUU fishing?

1. Not involved
2. Not that involved
3. Involved
4. Very involved

XII. In what illicit activities, apart from fisheries, could artisanal fishing vessels be involved?

a. Theft in general
b. Fuel smuggling
c. Illegal drugs trafficking
d. Pollution
e. Write other

XIII. Do you believe that artisanal fishing vessels should be included within the scope of SIMTRAC?

1. Yes
2. No