UNIVERSITY OF THESSALY
SCHOOL OF AGRICULTURAL SCIENCES
DEPT. OF ICHTHYOLOGY AND AQUATIC ENVIRONMENT

PhD Thesis

Analyzing the economic structure and productivity in the fisheries sector of the Central-Eastern Mediterranean area

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Volos, 2018

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ABSTRACT

A lack of knowledge of the socio-economic characteristics of commercial fisheries has long characterised fisheries management with the main focus being placed on the biotic components while setting aside the human component. This knowledge deficit has also been caused by inadequate understanding in fisheries science of the labour component related to fishing activity and in the ability to properly estimate it. This lack of understanding has been one of the main barriers in the establishment of sustainable fisheries management.

Labour is at the heart of the socio-economic component of fisheries with labour costs representing the main cost component in fishing activities. Around the world, and throughout history, the crew-share has been the most used system to calculate remuneration in fisheries, allowing the crew to capture a proportion of the rent. However, this system has not always been well considered in the data collection process, with remuneration being typically collected as a single value, often from the vessel's or company's financial statements. This method of collecting data has likely led to imprecise estimations of the labour component.

Aside from remuneration, the study considered the main indicators related to labour, including measures of productivity and the interplay between these indicators. In the standard theory, increases in productivity have been viewed as positive outcomes. However, in this study, a trend was identified where employment in the sector was found to decrease as the national GDP increased. The sector compensated for the reduced labour pool by increasing productivity and, in reality, labour productivity was generally most affected by factors external to the fishing sector and more related to the macroeconomic conditions of the country.

The main objective of this dissertation is an improved understanding of the labour component of fisheries and the related indicators providing insight into the remuneration of fisheries labour; improving the methodology for the collection of socio-economic data; introducing an *unconventional* methodology for the calculation of remuneration; and investigating the interplay between efficiency and other labour-related indicators.

The earlier literature on labour considered it to be a cost, like in case of classical bio-economic models which did not consider remuneration beyond the value reported in the ledgers. An improved quality of data on labour in fisheries provides an insight into the remuneration-related contribution to fishers' livelihoods and sheds light on the remuneration systems in fisheries around the world and the, to-date, dominance of the crew-share system.

The labour-related indicators were examined in the context of the Mediterranean region with a particular focus placed on Italy, Greece, Egypt and Lebanon. These countries had macroeconomic conditions covering the full range of income levels, but all conducted their fisheries in the Mediterranean Sea with similar fishery management systems and even some shared stocks. These countries were selected because they all have socio-economic data collection programmes with comparable methodologies and this yielded data with a high degree of consistency and comparability. Moreover, the author was directly involved in the data collection in these countries.

Remuneration, under the crew-share system, can also be used as an indicator of the contribution to fishers' livelihoods and as an indicator of the overall economic performance of the fishery, not only as a mere input cost.

A paradigm links the factors that impact labour productivity. The higher the income level, the lower the attractiveness of the sector and thus employment on board, which results in higher labour productivity performance once the fleet is able to increase mechanization. A negative correlation was identified between labour productivity and remuneration and labour productivity was more closely related to the macro-economic conditions of the country.

Concerning labour productivity, the findings of the dissertation suggested that: (i) the contribution to livelihoods is not well captured by the labour productivity indicator; (ii) variations in its performance appear to be the result of adaptations within fisheries to outside macroeconomic factors; (iii) the crew-share system makes labor costs a fixed share of the gross profits and the total amount of labor costs is fixed so, the number of crew members has a limited impact on profits. This, to a large extent, shifts the influence in the determination of labor productivity to the employment factor; and (iv) labor productivity should not be used as a stand-alone indicator, but should rather be considered in combination with other indicators.

The contribution of this dissertation emphasizes that fisheries management cannot be successfully conducted without well considering the human component of the activity while offering an improved understanding of labour-related indicators along with the tools to improve data quality.

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CRS: Constant returns to scale

DMU: Decision Making Unit

EEZ: Exclusive economic zones

FAO: Food and Agriculture Organization of the United Nations

GCF: Gross Cash Flow

GFCM: General Fisheries Commission for the Mediterranean

GVA: Gross Value Added

IL: Inactivity level

ILO: International Labour Organization

LOA: Length Overall

LP: Labour productivity

MTI: Medium-term indicator

PIM: Perpetual inventory method

REM: Remuneration per fisher/minimum wage of the country

STP: Short-term performance

VRS: Variable returns to scale

WTO: World Trade Organisation

STATEMENT OF ORIGINALITY

I hereby certify that the work submitted in this dissertation is my own and has not been submitted previously in substance or separately for any other degree.

DECLARATION

Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this dissertation are the work of the named candidate and have not been submitted for any other academic award.

ACKNOWLEDGEMENT

I would like to thank my supervisor Professor Konstantinos Polymeros. It has been a privilege to be one of his PhD students and I thank him for his supervision and patience throughout the course of my studies. I also specially thank Professor Constantinos Katrakilidis and Professor Christos Neofytou, for their oversight on my research and precious suggestions and encouragement. I am particularly indebted to Jennifer Gee, officer of the Food and Agriculture Organization of the United Nations, for her guidance on the analysis we have done together, her support writing articles and for always being there to answer my questions. The socio-economic structure and productivity analysis of fisheries are no doubt a fascinating topic to study. My special thanks to Mark Dimech, officer of the Food and Agriculture Organization of the United Nations, who introduced me to the international component of the work and first believed in my 'local' skills and for the extremely interesting and inspiring work we have done together in many Mediterranean countries. I also thank him for all the exciting conversations we have had on fisheries.

My deep gratitude goes to Irene Tzouramani, Angelos Liontakis and Alexandra Sintori for their encouragement and their support in my research.

Special thanks go to the many fishers I have meet and from whom I have learned what fisheries are really about. This all started with the fishers from Gioiosa Marea, my village, who infected me with this passion for fishing.

All of my colleagues in NISEA have offered much support and comradery. Also, I thank Professor Gianluigi Coppola for his comments and support for the critical sections of my dissertation.

I am, of course, always grateful to the continuous support received from my parents throughout all the years I have spent in education - without them, I would not be here. I thank my wife Laura for her patience and fundamental support throughout all the years of my research as none of this work would have been possible without it and I am also thankful to both to my sons, Achille and Alessandro, for their cheerfulness and for the long weekends they have spent playing next to my desk as I worked.

CHAPTER 1: INTRODUCTION

1.0. Introduction

"…After going a little farther, he saw James the son of Zeb'e·dee and his brother John, while they were in their boat mending their nets, and without delay he called them. So, they left their father Zeb'e·dee in the boat with the hired men and went off after him"

St. Mark Chapter 1:20.

As mentioned in the Bible, today, as two millennia ago, the matter of labour, crews and socio-economics were components of fisheries activities and they cannot be ignored in the course of managing a fishery. When fisheries management has been first introduced, the initial focus area has usually been on the marine ecosystems and on the monitoring of the status of captured species through the collection of biological and landings data, while the human component has been set aside. This lack of knowledge of the socio-economic characteristics of commercial fisheries turned out to be one of the largest barriers to the establishment of sustainable fisheries management and in many cases, it did not prevent a 'tragedy of the commons' (Hardin, 1968) from happening.

Labour, the main cost component of fisheries, has been found to have a global range between 30 % and 50 % of total costs (World Bank and FAO). In the European Union (EU), fishing fleet labour costs were estimated at 36 % of total costs in 2012 (STECF, 2014) and 39 % for the fleet in the eastern Mediterranean (FAO EastMed, 2016). In Italy in 2012, the average labour cost was 33 % of total costs (STECF, 2014). In small-scale fleets generally, and specifically in the small-scale fleet in the eastern Mediterranean, labour costs were even higher at 47 % (FAO EastMed, 2016).

In spite of its global importance, the labour component has not always been fully understood and so its estimation has also been of lower quality. A sound estimation of the livelihoods of people directly involved in the activities is particularly critical for understanding fisheries (Grafton, 2006). Also, it represents the main constraint in any data collection programme and in the consequent analysis. Remuneration is certainly the most important socio-economic indicator to estimate but it is also the most challenging to estimate and it constitutes the biggest component of any socio-economic analysis of fisheries.

Globally and throughout history, remuneration, made through some form of a crew-share payment, has been the dominant payment method in fisheries. This has also allowed crews to capture part of the rent and prevented forms of inequality.

In the analysis of a fishery, remuneration is important for two reasons: i) as it is often paid to the crew as shares proportional to income and therefore its performance is proportional, in the long term, to overall economic performance; and ii) earnings and employment provide a measure of the contribution to the livelihood of fishers. So then, a socio-economic survey that provides estimations of remuneration that are close to reality is a successful survey (Pinello et al., 2017). All of these factors have motivated the series of questions below, upon which the dissertation has been based.

On what basis is remuneration made for fishers? How common is the crew-share system? Why is the crew-share system so common? Are labour costs, as they are typically reported, accurate? How can the collection of remuneration be improved and incorporated in regular data collection programmes? How can efficiency be measured in the Mediterranean? Is labour productivity performance a reflection of factors inside or outside fisheries? Is positive labour productivity performance an indication of good conditions for the fishers? Are labour productivity and remuneration related to each other?

1.1 Aims and objectives

The aim of this dissertation is to answer the broad questions set out above by in-depth studies conducted with a focus on the Mediterranean region. The dissertation has one general objective and three specific objectives. The general objective is to further the understanding of economic structure and productivity as observed through the labour related components in fisheries. The three specific objectives are as follows: First, improve the methodology for the collection of socio-economic data. Second, introduce a new methodology to calculate remuneration. Third, investigate the interplay between productivity, efficiency and other labour-related indicators.

The key hypotheses to be tested are:

- The form of the crew-share system applied is a reflection of the cost structure of the fisheries.
- Remuneration calculated through the crew-share formula is more accurate than ledger values.
- Being proportional to revenues, remuneration can be used as an indicator of socio-economic performance.
- Input oriented data envelopment analysis is most appropriate for fisheries management contexts based on input controls and can be run using values rather than quantities.
- Labour productivity and employment levels on vessels are also driven by factors outside of the fisheries.
- Labour productivity can be used as a stand-alone indicator.

The study used, primarily, data from four Mediterranean countries, Egypt, Lebanon, Italy and Greece. The countries were selected as, together, they present an interesting case due to their diverse macroeconomic conditions while their fleets operated in the same area and this allowed for insightful comparisons. To the extent of the author's knowledge, no in-depth studies have been conducted on these labour related indicators in the area.

This dissertation investigates improved methodologies for collecting and analyzing labour-related data and efficiency performance for fisheries. When remuneration has been calculated through an indirect approach, it has been proposed that making use of other data that can be collected with more ease and accuracy allows for a more exact calculation of remuneration values. The investigation began with the mechanism and extent of application of the crew-share system throughout fisheries. A precise data collection scheme is set out.

Under a crew-share system, remuneration can be used as an indicator that captures a measure of the quality and representativeness of the socio-economic data. For labour productivity an investigation was made across and between countries with an examination of the potential drivers of labour productivity performance. In this dissertation a set of socio-economic indicators were also proposed– both internal and external to the fisheries. Finally, the social sustainability of fisheries, which must be supported for effective policy regimes, is not particularly captured, nor supported, by labour productivity and it is raised that it should not be considered a stand-alone indicator of the socio-economic performance of a fishery, but within the context of the wider suite of indicators. This is important if a more complete understanding of the contribution to livelihoods in fisheries is to be made.

1.2. Outline of dissertation

The research questions investigated in this dissertation are outlined in the following chapters:

Chapter two describes the socio-economic dimensions in fisheries globally and in the Mediterranean. It provides background information on the description of fisheries in terms of the number of fishing vessels, employment, production and fish trade. Finally, a focus is placed on remuneration and labour-related indicators.

Chapter three provides a discussion of the methodology and data used throughout this dissertation. In the course of this chapter both the theory behind survey sampling as well as the practical application of surveys and the subsequent application of empirical tools are discussed. These are all aimed towards the collection of the information most relevant for analyzing the efficiency and socio-economic characteristics of fisheries. After the variables were defined in the first section of this chapter, the indicators were calculated with reference points introduced to benchmark the performance of the indicator to reveal fluctuations in performance for the elements of interest.

Chapter four investigates the remuneration under the crew-share system and then labour-related indicators in two sections. In the first section, remuneration is examined. It was found that under the crew-share system, remuneration is the most important socio-economic characteristics of a fishery as it is an indicator of socio-economic performance and contribution to the fishers' livelihoods. In the second section, the interaction between the elements used to calculate labour productivity were examined along with the role of factors internal and external to fisheries. Remuneration is compared to the minimum wage and used as a proxy for the contribution to livelihoods and thus the attractiveness of work in the sector. The results of both studies and the implications for good quality socio-economic data for fisheries management, were discussed along with the conclusions.

Chapter five brings together the methodologies proposed, and the results obtained throughout this dissertation (chapters two - four) in order to obtain: an improved data collection methodology, refinement of the utility and application of labour-related indicators and the policy implications from the results. In addition, avenues for further research are addressed focussing particularly in fisheries employing non-local labour.

1.3. Originality and contribution to knowledge

This dissertation is original in that no other study has ever before empirically established the novel collection methodology for remuneration under the crew-share system in fisheries. This is complemented by the proposal that remuneration, under the crew-share system can also function as an indicator of the economic performance, particularly in the case of small-scale fisheries. The second contribution made by this dissertation was to conduct an analysis of the labour-related indicators in the region. Specifically, the analysis was about labour productivity and the influence of drivers external to the fisheries sectors influencing full-time equivalent employment (FTE) and productivity. In summary, this dissertation presents a mix of original methodological contributions complemented by empirical contributions to knowledge for a more accurate and nuanced understanding of the socio-economic factors that drive fisheries.

CHAPTER 2: SOCIO-ECONOMIC DIMENSIONS IN FISHERIES

2.0. Introduction

The purpose of this Chapter is to outline the broader context of the socio-economic dimensions of fisheries by providing background information on the description of fisheries in terms of the number of fishing vessels, employment, production and fish trade. From this, it will be evident that the fisheries sector is an important global activity that makes a significant contribution to the economy and to the labour force, and this is particularly true in the coastal regions of the world. The study area, constituted by four Mediterranean countries, is presented here and it reveals an interesting and unique case as they are characterised by highly diverse socio-economic conditions and a wide spectrum of income levels. This provides an opportunity to draw meaningful comparisons between them, and to add depth and richness to the analysis.

The typical cost structure in fisheries is presented as well as an exploration of the extent of crew-share remuneration system. Following this, a focus is placed on the limitations of information related to the remuneration. Finally, a proposed list of labour-related indicators is presented and then described.

2.1. Description of the fisheries

The data presented in section 2.1, has been elaborated based on the data provided in the FAO publication SOFIA 2014 (FAO, 2014) containing data from 2012, unless otherwise noted. 2012 was used as the reference year for the data as it was the most recent data available for all countries.

2.1.1 The fishing fleets

The global number of fishing vessels has been estimated in 2012 at approximately 4.72 million. Asia's fleet accounted for the largest share (68 % or 3.23 million vessels), followed by the African fleet with 16 % of the total, the Latin American and Caribbean fleet with 8 %, the North American with 2.5 % and the European fleet with 2.3 %. Most of the fishing vessels were considered to be operating in marine waters (68 % or 3.2 million vessels), with the remainder found operating in inland waters (32 % or 1.5 million vessels).

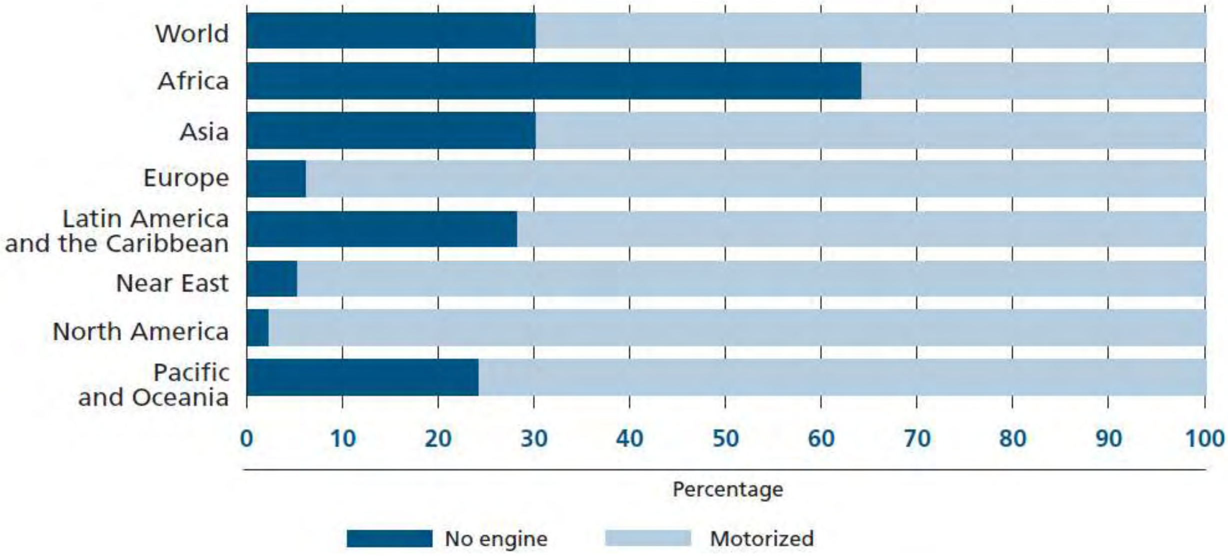

Figure 1. Proportion of marine fishing vessels with and without engine by region in 2012
Source: FAO, 2014

Engine-powered vessels in 2012 accounted for 57 % of the world's fishing vessels. However, marine-operating vessels had a much higher motorization ratio, at 70 %, compared to the inland fleet, which showed a motorization ratio of 31 %. Moreover, the world's motorized fishing fleet is unevenly distributed among regions and Asia accounted for 72 % of it, the highest proportion of motorized vessels by far (Figure 1).

Significant differences also existed among regions in the proportion of non-motorized vessels in the marine fleet. The figure for the Near East and Europe was around 5-6 %, while for Africa it was as high as 64 % (Figure 1). There was a low percentage of non-motorized vessels in North America, which could be accounted for by low rates of reporting or specific data collection systems used in this region.

Vessels less than 12m length overall (LOA) dominated all regions in 2012, accounting for around 79 % of all motorized fishing vessels globally and were prevalent especially in Latin America and the Caribbean, Africa and the Near East. Their dominance is still higher in inland waters fisheries, representing over 91 % of all motorized vessels operating here. As an inadequate appraisal of small vessel figures can occur, whether they are registered or not, these may not be included in national statistics. This can lead to a skewed estimation of the importance of this segment relative to the industrial component of fisheries for social, economic and food security considerations. This informational problem is more severe for inland water small vessels, which are often not required to be locally or nationally registered.

Industrialized vessels of 24 m and over represented around 2 % of all motorized fishing vessels and their proportion was greater in the Pacific and Oceania region, Europe and North America, while their number operating in marine waters was about 64 000, which is roughly three times over the number of fishing vessels registered with a unique identification number as provided by the International Maritime Organization.

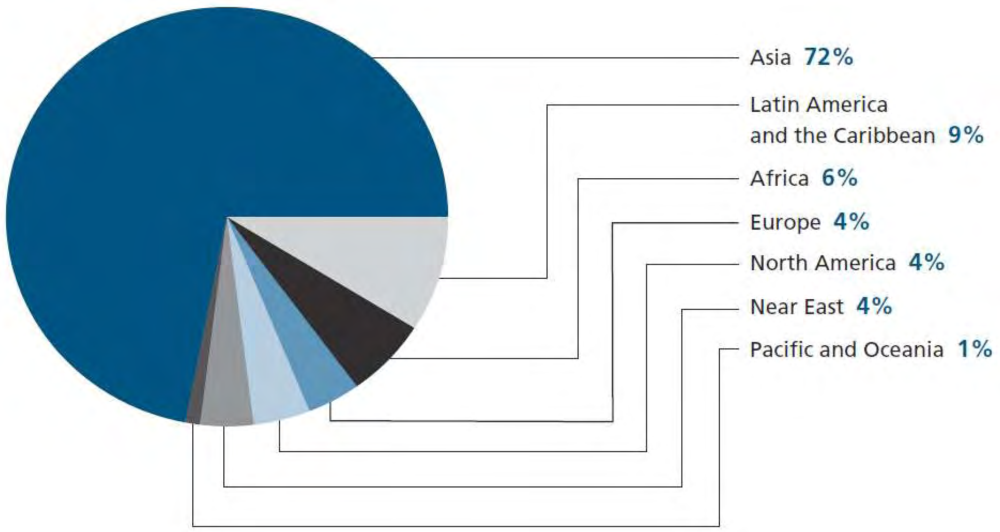

Figure 2. Distribution of motorized fishing vessels by region in 2012.

Source: FAO, 2014

2.1.2 The fishing fleets in the Mediterranean

FAO estimated that the commercial fishing fleet active in the Mediterranean and the Black Sea was composed of around 92 700 vessels (Table 1) and that it directly generated about 314 000 jobs (Sauzade and Rousset, 2013). As data on some segments of the fleet, particularly the small-scale segment, from some Mediterranean and Black Sea Riparian States or non-State actors is lacking, this figure is likely to underestimate the true size of the fleet (FAO, 2015). The greatest proportion of vessels is found in the Eastern and Ionian sub regions, with 28 and 27% respectively. These are followed by the Western sub region, with 19% of the total. The largest fleets are found in Turkey with 17.7% of the total, Greece with 16.9%, Tunisia with 14.9% and Italy with 13.4% (Table1).

Table 1. The reported fishing fleet per country in the Mediterranean

Country	Number of vessels	% of the total
Albania	511	0.55
Algeria	4 778	5.15
Bulgaria	704	0.76
Croatia	7 733	8.34
Cyprus	943	1.02
Egypt	2 988	3.22
France	1 461	1.58
Georgia	47	0.05
Greece	15 688	16.92
Israel	400	0.43
Italy	12 469	13.45
Japan	229	0.25
Lebanon	2 623	2.83
Libya	4 641	5.00
Malta	1 015	1.09
Monaco	na	
Montenegro	135	0.15
Morocco	2 146	2.31
Palestinian Territories	759	0.82
Portugal	2	0.00
Romania	159	0.17
Russian Federation	33	0.04
Slovenia	168	0.18

Spain	2 663	2.87
Syrian Arab Republic	31	0.03
Tunisia	13 826	14.91
Turkey	16 447	17.74
Ukraine	135	0.15
TOTAL	**92 734**	**100.00**

Source of data: FAO, 2016b

Engine-powered vessels represent more than 90 % of the fishing fleet. Small-scale vessels generally are the dominant segments of the fleet, representing around 80 % of the total. The exceptions are Portugal, which reported just two polyvalent vessels over 12 m of Length Overall (LOA) operating in 2013, Georgia, with 4 %, Egypt, with 20 % and Spain at 40 %.

Turkey and Italy, according to tonnage and engine power, together account for 35 % of total fishing capacity in the Mediterranean, thus resulting the countries with the largest fishing capacity in this area. Substantial capacity also exists in fleets from Libya, Algeria, Tunisia, Greece, Egypt, Croatia and Spain. Regional importance in terms of numbers is exhibited also by other fleet segments including trawlers (12-24 m LOA), purse seiners (>12 m LOA), long liners (>6 m LOA) and polyvalent vessels (>12 m LOA). Regarding the contribution to total landings, purse seiners (>12 m LOA) account for the largest share, represented by 41 %, with trawlers (12-24 m LOA) following, with 14 %, then polyvalent vessels (>12 m LOA) and polyvalent small-scale vessels (6-12 m LOA), generating around 10 and 9 % respectively of landings. As far as the value of landings is concerned, three segments stand out as being more noteworthy: trawlers longer than 12 m LOA (sum of trawlers 12-24 m LOA and trawlers > 24 m LOA), representing 38 % of total landed value, purse seiners longer than 6 m LOA (sum of purse seiners 6-12 m LOA and purse seiners > 12 m LOA), with 27 % of landed value, and polyvalent small-scale vessels up to 12 m LOA (polyvalent small-scale vessels), landing 22 % of total landed value.

2.1.3 The employment

The fisheries sector is a source of income and livelihood for many millions of people globally. The 2012 estimate shows that 39.4 million people engaged in the capture fisheries primary sector, of which 37 % on a full-time basis, 23 % part-time and the balance either occasionally or in an unspecified status. In the same year, 78 % of all people employed in the fisheries sector were found in Asia, over 10 % in Africa and 5 % in Latin America and the Caribbean.

Over 1990-2012 total employment in the fisheries sector has grown at a faster rate than the rate of world population growth and faster than employment in the traditional agriculture sector (Table 3). The 39.4 million fishers of 2012 were equal to 3 % of the 1.3 billion economically active population in the broad agriculture sector globally.

Table 2. World fishers by region

	Thousand tonnes					
	1995	**2000**	**2005**	**2010**	**2011**	**2012**
Africa	2 327	4 084	4 290	4 796	4 993	5 587
Asia	23 534	27 435	29 296	31 430	30 553	30 865
Europe	474	676	614	560	553	544
Latin America and the Caribbean	1 348	1 560	1 668	1 937	1 966	1 982
North America	376	340	319	315	315	314
Oceania	117	121	117	119	122	121
World	**28 176**	**34 216**	**36 304**	**39 157**	**38 502**	**39 413**

Source: FAO, 2014

Trends in the number of people active in the fisheries primary sector over the last two decades have shown regional variations. As Table 3 shows, Europe and North America, which have experienced very low population growth rates and falling economically active populations in the agriculture sector, have experienced, in percentage terms, the largest reduction in the number of people active in capture fishing. Africa and Asia, on the other hand, with higher population growth rates and an increasing economically active population in the agricultural sector, have witnessed a growing number of people engaged in capture. The Latin American and Caribbean region is placed somewhere in between, experiencing declining population growth rates and economically active populations in the agriculture sector over the last decade, with at the same time employment in the fisheries sector growing moderately. In China over 14 million people (25 % of the world's total) are active as fishers (representing 16 % of the world total). Generally, fishing employment shows a declining trend in capital-intensive economies, particularly in most European countries, North America and Japan. Over 1995 to 2012, for example, employment in marine fishing declined by 30 % in Iceland, 42 % in Japan, and by 49 % in Norway. Possible explanations for this include: the pursuit of policies to reduce fleet overcapacity; and technological development and its consequent efficiency improvements, which reduced the need for labour power.

Table 3. Comparative average annual percentage growth rate by region and period

	1990–1995	**1995–2000**	**2000–2005**	**2005–2010**
World Total population	**1.5**	**1.3**	**1.2**	**1.2**
Economically active population in agriculture	0.8	0.6	0.6	0.5
Capture fishers	1.4	4	1.2	1.5
Capture production	1.8	0.2	–0.2	–0.8
Africa Total population	**2.6**	**2.4**	**2.4**	**2.5**
Economically active population in agriculture	2.2	2.1	2.1	2.1
Capture fishers	4	11.9	1	2.3
Capture production	3.1	2.8	2.3	0.4
Asia Total population	**2**	**1.3**	**1.2**	**1.1**
Economically active population in agriculture	1	0.5	0.5	0.4
Capture fishers	1.1	3.1	1.3	1.4
Capture production	2.7	1.5	0.5	1.8
Europe Total population	**–1.6**	**0**	**0.1**	**0.2**
Economically active population in agriculture	–7.7	–3.5	–3.0	–2.9
Capture fishers	5.1	7.3	–1.9	–1.9
Capture production	–2.6	–1.2	–3.1	0
Latin America and the Caribbean Total population	**1.8**	**1.6**	**1.3**	**1.2**
Economically active population in agriculture	0.3	0.1	–0.2	–0.7

Capture fishers	1.2	3	1.4	3
Capture production	6	–1.5	–1.2	–8.5
North America Total population	**1.1**	**1.2**	**0.9**	**0.9**
Economically active population in agriculture	–2.2	–1.5	–2.1	–1.9
Capture fishers	–0.5	–2.0	–1.3	–0.3
Capture production	–3.4	–1.1	1.2	–2.2
Oceania Total population	**1.5**	**1.5**	**1.5**	**1.7**
Economically active population in agriculture	1.2	1.3	1.4	1.6
Capture fishers	0.6	0.7	–0.6	0.2
Capture production	6.5	1.4	–4.2	6.7

Source: FAO, 2014

2.1.4 The employment in the Mediterranean

Official statistics provided by the General Fisheries Commission for the Mediterranean (GFCM), show that nearly a quarter of a million people (221 797), or around 0.11 % of the total working population in Mediterranean countries in which data is reported, are directly employed on fishing vessels in this area. Total working population data was obtained through an extrapolation of World Bank population data and International Labour Organization (ILO) statistics on percentage of economically active population. This statistic excludes employment in additional jobs of the type also largely dependent on the fishing industry (for example fish processing, fish marketing or boat maintenance). These have been estimated as possibly accounting for up to half of total employment in the fisheries sector (Sauzade and Rousset, 2014). Approximately 55 % of total direct employment in the fisheries sector in the Mediterranean is accounted for by the small-scale segment, with higher levels in the eastern and Ionian areas. In the Adriatic and western areas trawlers tend to be more common, while in the western area mainly purse seiners are present.

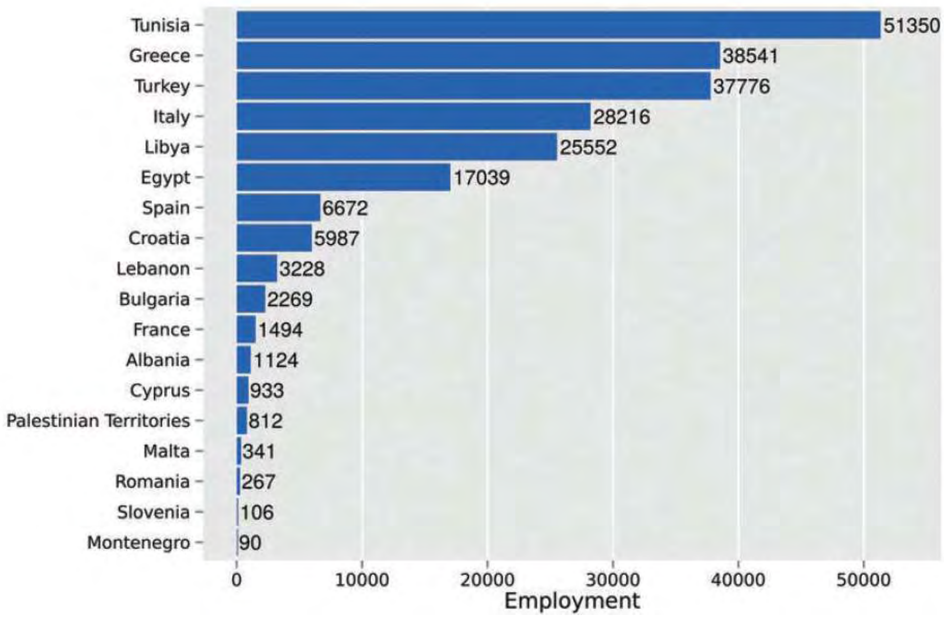

Figure 3. Total employment on fishing vessels in the Mediterranean
Source: FAO, 2016b

Total employment on fishing vessels as a percentage of total working population is presented in Figure 4. This indicates the fishing sector's contribution to national employment. The data shows, for instance, that the fishing industry is relatively important for employment in Tunisia, with nearly 1.2 Tunisians every 100 employed on fishing vessels. Fishing is much less significant in Romania as an employer, with only 2.4 Romanians every 100 000 employed on fishing vessels here.

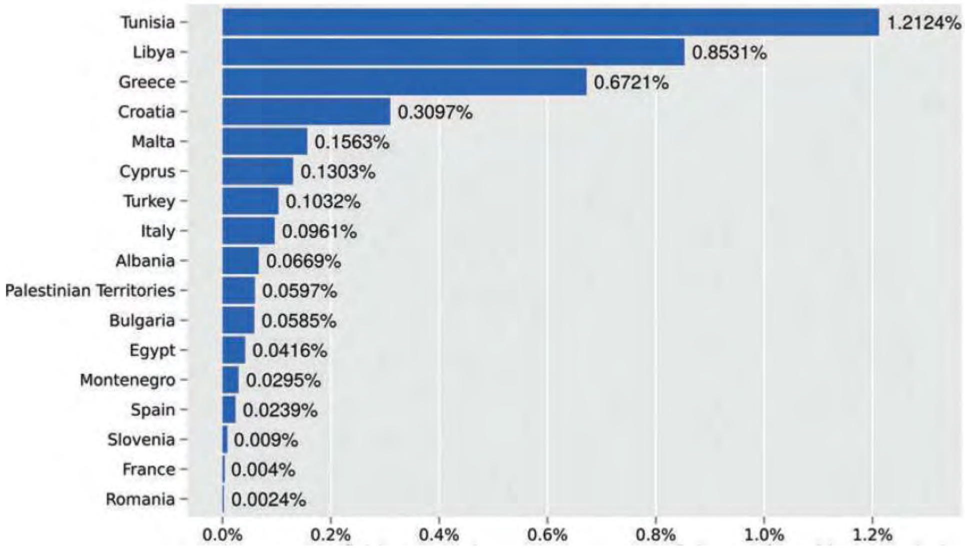

Figure 4. Total employment on fishing vessels as a percentage of the total working population in the Mediterranean.
Source: FAO, 2016b

2.1.5 World marine capture production

Global marine water fishery production was 82.6 million tonnes in 2011 and 79.7 million tonnes in 2012, though excluding anchoveta the figures were 74.3 and 75.0 million respectively for the same years. Over these two years, 18 countries caught at least one million tonnes per year on average, and together accounted for over 76 % of global marine catches (Table 4). Of these, eleven were in Asia, including the Russian Federation, which fishes prevalently in the Pacific Ocean rather than in the Atlantic Ocean, and most of which have shown significant increases in marine catches over the last decade, except Japan and Thailand, which registered decreases, and the Philippines and the Republic of Korea, which registered only slight increases. Despite the Russian Federation, India and Malaysia reporting declining catches in some years.

Table 4. Marine capture fisheries: major producer countries

Tonnes	Variation

				(percentage)	
Country Continent	**2003**	**2011**	**2012**	**2003/ 2012**	**2011/ 2012**
1 China Asia	12 212 188	13 536 409	13 869 604	13.6	2.4
2 Indonesia Asia	4 275 115	5 332 862	5 420 247	27	1.7
3 United States of America Americas	4 912 627	5 131 087	5 107 559	4	–0.5
4 Peru Americas	6 053 120	8 211 716	4 807 923	–20.6	–41.5
5 Russian Federation Asia/ Europe	3 090 798	4 005 737	4 068 850	31.6	1.6
6 Japan Asia	4 626 904	3 741 222	3 611 384	–21.9	–3.5
7 India Asia	2 954 796	3 250 099	3 402 405	15.1	4.7
8 Chile Americas	3 612 048	3 063 467	2 572 881	–28.8	–16.0
9 Viet Nam Asia	1 647 133	2 308 200	2 418 700	46.8	4.8
10 Myanmar Asia	1 053 720	2 169 820	2 332 790	121.4	7.5
11 Norway Europe	2 548 353	2 281 856	2 149 802	–15.6	–5.8
12 Philippines Asia	2 033 325	2 171 327	2 127 046	4.6	–2.0
13 Republic of Korea Asia	1 649 061	1 737 870	1 660 165	0.7	–4.5
14 Thailand Asia	2 651 223	1 610 418	1 612 073	–39.2	0.1
15 Malaysia Asia	1 283 256	1 373 105	1 472 239	14.7	7.2
16 Mexico Americas	1 257 699	1 452 970 1	467 790	16.7	1
17 Iceland Europe	1 986 314	1 138 274	1 449 452	–27.0	27.3
18 Morocco Africa	916 988	949 881	1 158 474	26.3	22
Total 18 major countries	58 764 668	63 466 320	60 709 384	3.3	–4.3
World total	79 674 875	82 609 926	79 705 910	0	–3.5
Share 18 major countries (percentage)	73.8	76.8	76.2		

Source: FAO, 2014

Myanmar, Vietnam, Indonesia and China have reported marine catches to FAO showing continuous growth, on some occasions even astonishing decadal increases (e.g. an increase in Myanmar of 121 % and in Vietnam of 47 %). On the other hand, the decline in capture production for Japan and Thailand of 22 and 39 % respectively, has been due to other reasons. Japan has been downsizing its fishing fleet since the early 1980s, while its northern coast was hit in March 2011 by a tsunami caused by one of the most powerful earthquakes witnessed in the world since 1990. Following the destruction of fishing vessels and infrastructure resulting from this dramatic event, Japan's total catch had been forecast to decline by around 30 %. Instead, the actual fall relative to 2010 was only around 7 %, falling again in 2012 by only a further 3.5 %.

Thailand's catches instead have fallen significantly due to the exhaustion of some marine resources because of overfishing and environmental degradation in the Gulf of Thailand, as well as the end of fishing operations in Indonesian waters by Thai vessels since 2008. Extensive fishing by Asian countries has resulted in the Northwest and Western Central Pacific areas showing the highest catches, which are continuing to grow (Table 5). In the Southeast Pacific, production is constantly and strongly affected by climatic variations. In the Northeast Pacific, the total catch between 2012 and 2003 was constant, despite strong yearly fluctuations for the major species, i.e. Alaska pollock and salmon. Growth in the total catch in the Indian Ocean seems to be continuously improving. In 2012 two new record-breaking total catches of 4.5 and 7.4 million tonnes were recorded for the Western and Eastern fishing areas respectively. After declining by 30 % in the period from 2007 to 2009, due to piracy deterring fishing operations, total tuna catches in the Western Indian Ocean have rebounded since 2010.

While the decreasing catches in the North Atlantic, Mediterranean and Black Sea areas seemed to have come to an end by the beginning of the second decade of 2000, data for 2011 and 2012 again indicated declining catches.

Table 5. Marine capture: major fishing areas

		Tonnes			**Variation (percentage)**	
Fishing area code	**Fishing area name**	**2003**	**2011**	**2012**	**2003–2012**	**2011–2012**
21	Atlantic, Northwest	2 293 460	2 002 323	1 977 710	–13.8	–1.2
27	Atlantic, Northeast	10 271 103	8 048 436	8 103 189	–21.1	0.7
31	Atlantic, Western Central	1 770 746	1 472 538	1 463 347	–17.4	–0.6
34	Atlantic, Eastern Central	3 549 945	4 303 664	4 056 529	14.3	–5.7
37	Mediterranean and Black Sea	1 478 694	1 436 743	1 282 090	–13.3	–10.8
41	Atlantic, Southwest	1 987 296	1 763 319	1 878 166	–5.5	6.5
47	Atlantic, Southeast	1 736 867	1 263 140	1 562 943	–10.0	23.7
51	Indian Ocean, Western	4 433 699	4 206 888	4 518 075	1.9	7.4

57	Indian Ocean, Eastern	5 333 553	7 128 047	7 395 588	38.7	3.8
61	Pacific, Northwest	19 875 552	21 429 083	21 461 956	8	0.2
67	Pacific, Northeast	2 915 275	2 950 858	2 915 594	0	–1.2
71	Pacific, Western Central	10 831 454	11 614 143	12 078 487	11.5	4
77	Pacific, Eastern Central	1 769 177	1 923 433	1 940 202	9.7	0.9
81	Pacific, Southwest	731 027	581 760	601 393	–17.7	3.4
87	Pacific, Southeast	510 554 479	12 287 713	8 291 844	–21.4	–32.5
18, 48, 58, 88	Arctic and Antarctic areas	142 548	197 838	178 797	25.4	–9.6
	World total	79 674 875	82 609 926	79 705 910		

Source: FAO, 2014

The Southwest and Southeast Atlantic areas have shown variable trends in the last 10 years; however, both these areas have seen the catch decreases of the late 2000s recovering in recent years.

Catches of Gulf menhaden (*Brevoortia patronus*), a clupeoid species that is processed into fishmeal and fish oil, that comes from the United States, accounts for roughly a third of total capture production in the Western Atlantic. Due to the Deepwater Horizon oil spill, an unexpected closure of long-established menhaden fishery fishing grounds took place in 2010, while in 2011, the substantial level of catches led to the overall total for the Western Central Atlantic recovering to a level not seen since 2004 of around 1.5 million tons. The low quality of data or non-submission of fishery statistics by many Caribbean and coastal states hinders the comprehensive analysis of catch trends in this area. In an analogous way, it must be considered that for a realistic assessment of the trend in the Eastern Central Atlantic area, where the highest catch level was reached at 4.4 million tons in 2010, catch data is needed for all distant-water fleets fishing in West African Country Exclusive economic zones (EEZ). With regards to this, some coastal countries, such as for example Guinea-Bissau or Mauritania, provide information on such catches to FAO. This is then cross-checked with the data provided by the flag States, and those catches that had not been reported to FAO are then added to the FAO database. However, as some foreign vessels operate in joint ventures with local companies, this makes the correct ascription of catch nationality more complex and at the same time avoiding catch recording easier.

2.1.6 Marine capture production in the Mediterranean

In the Black Sea, landings increased swiftly from about 400 000 tonnes in 1970 to over 900 000 tonnes in 1988, mainly due to the development of the small pelagic fishery in the area (FAO, 2016a). Following 1988, an abrupt collapse of the anchovy fishery saw landings fall to between 300 000 and 600 000 tonnes, totalling 376 000 tonnes in 2013 (FAO 2016a), and with considerable fluctuations in between years. In the Mediterranean and Black Seas total commercial landings rose in an irregular pattern from around 1 million tonnes in 1970 to nearly 2 million tonnes in 1982 (Figure 5). Thereafter, they remained stable over most of the 1980s and then declined in 1989 and 1990 (Figure 5), largely because of the collapse of pelagic fisheries in the Black Sea area (FAO, 2016a). In the Mediterranean basin however, landings continued to increase until 1994 to 1 087 000 tonnes. Nonetheless, following 1994, they also declined haphazardly here, reaching a level of 787 000 tonnes in 2013 (FAO, 2016a).

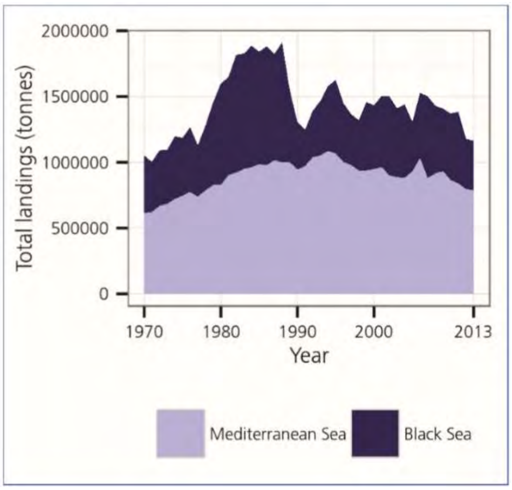

Figure 5. Trends in cumulative landings in the Mediterranean and the Black Sea between 1970 and 2013.
Source: FAO, 2016b

Table 6. Average landings in the 2000–2013 period in the Mediterranean and the Black Sea, sorted in decreasing order

Country	Average landings (t)	percentage
Turkey	459 400	31.18
Italy	249 500	16.93
Algeria	115 400	7.83
Spain	108 100	7.34
Tunisia	101 400	6.88
Greece	81 900	5.56
Ukraine	68 900	4.68
Egypt	67 300	4.57
Croatia	42 100	2.86
Libya	41 700	2.83
Morocco	35 600	2.42
Russian Federation	32 000	2.17
France	29 900	2.03
Georgia	12 600	0.86
Bulgaria	7 715	0.52
Lebanon	3 574	0.24
Albania	2 801	0.19
Syrian Arab Republic	2 768	0.19
Israel	2 643	0.18
Palestinian Territories	2 118	0.14
Cyprus	1 749	0.12
Malta	1 419	0.1
Romania	1 258	0.09
Slovenia	937	0.06
Montenegro	645	0.04
Monaco	2	0

Source: FAO, 2016b

Taking account of average landings for the period from 2011 to 2013, Turkey and Italy, with 459 400 and 249 500 tonnes respectively, were the countries which recorded the largest landing volume, accounting for over 30 and 15 % of total production in the basin respectively (Table 6). Over 80 % of total Mediterranean and Black Sea landings was recorded from these two countries together with Algeria, Spain, Tunisia, Greece and Ukraine (FAO, 2016a).

During the 1970s Turkey's landings were normally under 150 000 tonnes. However, these rose rapidly over the late 1970s and most of the 1980s, reaching 600 000 tonnes in 1988. Since this peak, however, landings have been registered between 300 000 and nearly 600 000 tonnes, with no clear trend and large fluctuations in between years.

For Italy, landings increased in an irregular manner from around 300 000 tonnes in 1970 to 400 000 tonnes in 1985, and since then have been spiralling downwards reaching 165 000 tonnes in 2013. Landings by Spain, Morocco, France and Russia have generally been relatively stable, although Spanish catches show a somewhat decreasing trend. Greece increased its landings over more than half the period, but since 1994 it has seen them decline. Large decreases for landings by Ukraine, Russia and Georgia have been seen from the late 1980s to the early 1990s.

Landings have been steadily increasing for Ukraine since the mid-1980s, for Russia since the 2000s and for Georgia they rose in the late 2000s. Bulgaria's landings have been fluctuating between 2 300 tonnes and nearly 20 000 tonnes, standing currently at nearly 10 000 tonnes. Romania's landings have fluctuated between 300 and about 16 000 tonnes, and currently stand at a low volume of 1 600 tonnes. Landings by Lebanon, Albania, Israel, Syrian Arab Republic, Palestinian Territories, Cyprus, Slovenia, Malta, Montenegro and Monaco stand at less than 10 000 tonnes, with Israel and Slovenia displaying a markedly decreasing trend, showing current landing figures of 2 200 and 232 tonnes respectively, while Monaco currently does not report any catches.

2.1.7 The fish trade

In 2012, the total volume of fish traded was 158 million metric tonnes and 136 million metric tonnes was for human consumption (Table 7). Of this total, 63 million tonnes were marketed as live, fresh or chilled. These forms corresponded to 54 % of fish intended for human consumption in developing countries in 2012, despite these countries having seen an increase in the share of fish products utilised as frozen products to 24 % in 2012. On the other hand, in developed countries this latter proportion rose to a record high of 55 % in 2012. A declining, though still significant share of world fisheries products are processed into fishmeal, mostly for high-protein feed, and fish oil, used as feed additive in aquaculture as well as for human consumption for health purposes. These can be produced from whole fish as well as from fish remains and other fish by-products, while around 35 % of world fishmeal production in 2012 was obtained from fish residues. Around 25 million tonnes of seaweeds and other algae are harvested annually and used as food, in cosmetics and for fertilizer production. They are also processed to extract thickening agents or used as additives in animal feed. Fish continues to be one of the most traded food commodities in the world and in 2012 around 200 countries reported fish and fishery product exports, while the fishery trade is particularly important for developing countries, accounting in some cases to over half the total value of traded commodities. In 2012, this trade accounted for around 10 % of the total value of agricultural exports and 1 % of the total value of world merchandise trade, while the share of total fishery production exported in various product forms, both for human consumption and for non-edible uses, grew from 25 % in 1976 to 37 % in 2012, equal to 58 million tonnes, live-weight equivalent. The peak of US$129.8 billion in fishery exports was reached in 2011, an increase of 17 % from 2010 levels, but then declined to US$129.2 billion in 2012 following declining international prices of selected fish and fishery products. The uncertain demand in many developed countries led exporters to seek out new markets in emerging economies, while preliminary estimates for 2013 indicate an increase in fishery trade.

Demand and supply factors influence fishery product prices, including production and transportation costs, but also the prices of substitute commodities such as meat and feeds. The FAO aggregate Fish Price Index increased considerably since early 2002 and reached a record high in October 2013 after fluctuating somewhat. Undoubtedly the largest exporter of fishery products is China, and since 2011 it has become the world's third largest importing country of such products, after the United States of America and Japan, while the European Union as a regional entity is the largest market for imported fish and fishery products with its dependence on imports rising.

Developing countries on the other hand, are seeing their share in fishery trade increasing with total fishery exports from these countries by value in 2012 reaching 54 % of the world total, and more than 60 % by quantity (live weight). This has been an important change in the fishery trade pattern, and at the same time, although developed countries continue to dominate world imports of fish and fishery products, their share is declining. Exports from developing countries have increased markedly in recent decades also because of lower tariffs, which has followed expended membership of the World Trade Organisation (WTO) and the entry into force of bilateral and multilateral trade agreements. Rising disposable incomes in emerging markets moreover, have expanded demand.

Table 7. Disposition of world fishery production

	1 000 tonnes	**%**
Total world fishery production	157 969	100.0
For human consumption	136 235	86.2
Marketing Fresh	62 613	39.6
Freezing	39 828	25.2
Curing	16 451	10.4
Canning	17 343	11.0
For other purposes	21 735	13.8
Reduction	16 345	10.3
Miscellaneous purposes	5 390	3.4

Source: FAO, 2014

2.1.8 The fish trade in the Mediterranean

In the Mediterranean area fish trade is an important activity that has increased over the past 30 years (Malvarosa and De Young, 2010), and particularly important are the trade relationships among the European Union (EU) and the non-EU GFCM contracting parties.

Malvarosa and De Young point out that non-European Mediterranean countries tend to import products of smaller commercial value from the EU, while exporting higher commercial value products such as molluscs, fresh and chilled fish and crustaceans to the EU.

Based on data from the FAO Fishery Commodities Global Production and Trade database, an estimation of the standardised trade balance is shown in Figure 6, where a value of minus one indicates 100 % imports, a value of plus one indicates 100 % exports and a value of 0 indicating a perfect balance between imports and exports.

It must be noted however, that the data for this analysis includes statistics for both capture fishery and aquaculture. Moreover, in the case of countries bordering more than one sea, such as France, Spain, Morocco, Egypt and the Russian Federation, trade data is not related to fishery products originating in the Mediterranean Sea alone.

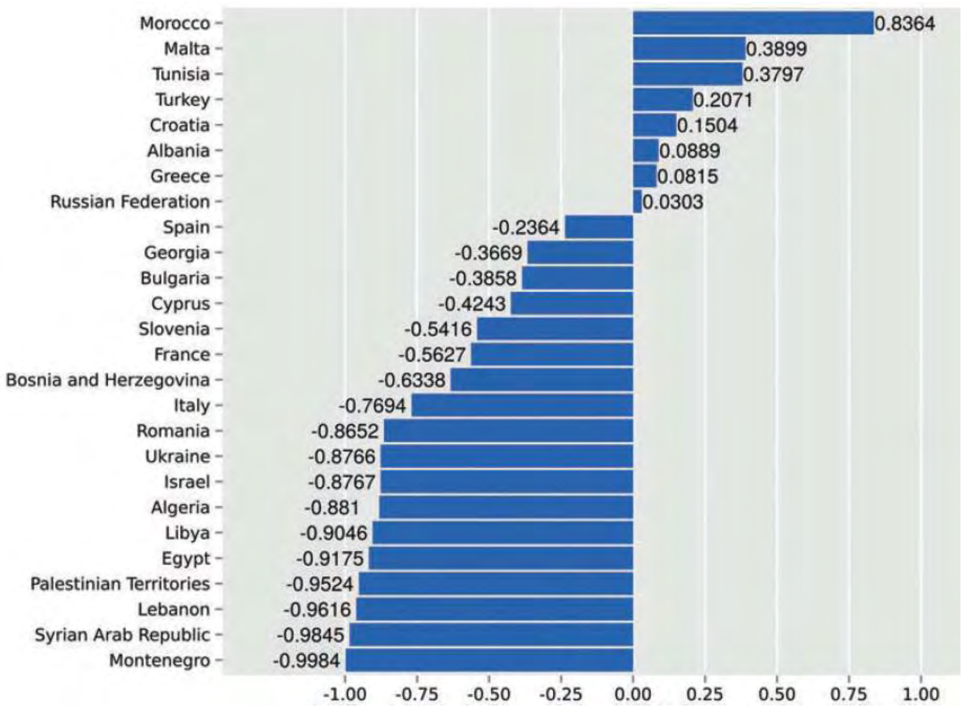

Figure 6. Standardized trade balance in the Mediterranean.
Source: FAO, 2016b

2.1.9 The study area

As shown in Table 8, the region this dissertation focuses on, and for which the socio-economic data and labour indicators have been analysed, is composed by the following four eastern Mediterranean countries: Egypt, Lebanon, Greece and Italy. The region in 2012 had a total population of 161 million people (The World Bank, 2017), about one-third of the total population of all of the Mediterranean countries. The GDP per capita values, both in current values and converted into Purchasing Power Parities (PPPs), together with the income level calculated by the Organisation for Economic Co-operation and Development (OECD), clearly showed as the region is characterised by highly diverse socio-economic conditions and levels of income (Gee et al., 2017). A pronounced north–south asymmetry is present across the macroeconomic indicators, with lower income levels concentrated in the southern countries and the macroeconomic conditions in the selected countries for the comparison represent the full spectrum of income levels observed in the fisheries of the semi-closed Mediterranean Sea. Table 9 shows the total landings (quantity and value) for the four study countries.

Table 8. Macroeconomic indicators, 2012

	Egypt	**Lebanon**	**Greece**	**Italy**
Population (million)	85.7	4.4	11.1	59.5
GDP per capita (current $)	3 068	9 729	22 147	34 845
GDP per capita, PPP (current $)	10 248	16 871	25 462	35 525
Income level	lower middle income	upper middle income	high income	high income
Unemployment, total (% of total labor force)	12.7	6.2	24.2	10.7

Source: The World Bank 2017. The ranges set for the 2012 definitions of income level (based on an estimate of gross National income per capita) were: lower middle income: US$1036–US$4085; upper middle income: US$4 086– US$12 615; high income: US$12 616 or more.

Table 9. Fisheries landings from the study countries, 2012

	Egypt	Lebanon	Greece	Italy	Total
Value of landings ($1000)	164,118	39,571	547,584	1,189,729	1,941,002
Volume of landings (t)	69,333	3566	93,500	196,783	363,182

Source: Pinello and Dimech, 2016

The fisheries in the four countries were all managed through input control largely based on fixed licence availability, temporal and/or spatial limitation, limits on the allowable gear types and, aside from Bluefin tuna, there were no quota systems in place (Cataudella and Spagnolo 2011; Pinello and Dimech, 2013; FAO EastMed 2014; Pinello et al., 2016). In 2012, the fisheries of the four countries landed a total of 363 thousand tons, worth US$1.9 billion and 62 % of the total value of landings in the Mediterranean (Pinello and Dimech, 2016). Egypt had the second largest trawl fleet in the Mediterranean (Sauzade and Rousset 2013; FAO. 2016c) while Lebanon was the only country without a trawl fleet (Pinello and Dimech, 2016).

The countries included in the analysis then had macroeconomic conditions representing a full spectrum of income levels with fisheries conducted in a similar environment, the semi-closed Mediterranean Sea, with similar management schemes in place, with many shared stocks (Pinello and Dimech, 2016; Gee et al., 2017) and even occasionally common fishing grounds (GFCM 2006, 2015). The fisheries of the regional allowed for a comparison to be made about fisheries that were at the same level of maturity, but with very different national economic conditions (Gee et al., 2017).

2.2. Main socio-economic indicators

An indicator has been defined as: "a variable, pointer, or index related to a criterion. Its fluctuation reveals variations in key elements of sustainability in the ecosystem, the fishery resource or the sector and social and economic well-being. The position and trend of an indicator in relation to reference points indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and actions" (FAO, 1999).

Socio-economic indicators in fisheries are utilised to analyze the economic activities of capture production, the effects on the livelihood of people and to support the conservation and management of fisheries activities (e.g. FAO, 2001). The socio-economic factors also have direct effects on ecosystems (Do Hoon and Zhang, 2011), for this reason, economic analyses should contribute to the design of fisheries policies and management plans that ensure adequate income for the fishers, profitability of the activities, and maintenance of stocks at sustainable levels (Pinello et al., 2017). Socio-economic indicators are then utilised with the aim of assessing:

- economic performance and cost structure
- livelihoods and employment
- profitability
- level of investments, debts and subsidies
- activity levels

In this respect, socio-economic indicators are key to formulating and implementing management with an understanding of livelihood contributions and for evaluating the fisheries performance to fulfill regional and international requirements (Pinello et al., 2017). The variables need operational definitions that are clear and universally accepted, allow for comparison between sectors and countries and "lend themselves to being adapted to different national contexts, analysed at different levels of aggregation and linked to more detailed indicator sets" (OECD, 2002). Finally, indicators allow policy makers and others to assess the performance of the sector without requiring prior knowledge of economics or statistics (The Economist, 2010).

Socio-economic indicators and their respective reference values are important for monitoring a fishery in relation to policies required to meet objectives (Bonzon, 2000; Franquesa et al., 2001; Accadia and Spagnolo 2006). An indicator has been defined as: “a variable, pointer, or index related to a criterion. Its fluctuation reveals variations in key elements of sustainability in the ecosystem, the fishery resource or the sector and social and economic well-being. The position and trend of an indicator in relation to reference points indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and actions” (FAO, 1999).

A large number of indicators of socio-economic performance of fisheries could be identified (Pinello et al., 2017; Unal and Franquesa, 2010) but when it comes to the socio-economic conditions of fisheries and particularly the labour related conditions, the suite of indicators that adequately describes the most significant socio-economic and labour-related conditions of a fishery, should include the following:

- *Total engaged crew:* The total number of people directly involved in fishing activity
- *Working days and hours:* the amount of time worked in the sector
- *Overall turnover:* the total value generated by the sector
- *Personnel costs:* all the labour-related costs, including total remuneration of crews, social security, social costs and pension contributions. They are fundamental for measuring the contribution to livelihoods for the fishers.
- *Energy costs:* cost of energy consumed by the fishing fleet
- *Other operational costs:* All the purchased consumable inputs
- *Commercial costs:* all the costs related to the first sale of the production

- *Repair and maintenance costs:* the costs for maintenance and repair to the vessel and gears
- *Fixed costs:* the costs that do not change on the basis of the activity of the vessel
- *Investments:* The value of all the assets utilized in the fishing activities
- *Gross value added (GVA):* the part of revenues that goes to cover remuneration, profit, opportunity cost and depreciation. It is a measure of the contribution to GDP made by the fisheries sector.
- *Economic profit:* The difference between revenue and total costs of the fishing vessels. It provides an indication of the sector's operating efficiency and it is often used as a proxy of resource rent in fisheries.
- *Capital costs:* the costs related to the capital invested in the sector
- *Labour productivity*: it measures the output per unit of labour.

2.3. The cost structure per fleet segment

In general, specific cost structures characterize different fishing fleets and affect the overall economic efficiency of the vessels belonging to the fishing segment. The cost structure, together with the fishing gears, the target species, the fishing areas, the technical characteristics of the vessels and its employment level, is an important component in the analysis of the socio-economic structure of fisheries. Cost structures can also be compared among vessels belonging to the same fleet segment operating under similar conditions, in order to identify the efficiency levels of the vessels and potential inefficiencies.

Globally, when analysing the breakdown of the costs, it is found that labour and energy together represent the main cost items in fisheries, with their proportion varying among areas and conditions. This is affected by many factors including the technical characteristics of the vessel, the efficiency of the engine and of the equipment, the catching methods, the subsidies on fuel and the taxation level. As a general rule, vessels using mobile gears (i.e. trawlers) are more energy consuming in relation to the fishing activity and therefore fuel constitutes a larger proportion of operational costs. On the contrary, in artisanal vessels and in vessels targeting pelagic species (i.e. purse seiner), labour makes up the larger proportion of the operational costs.

In the study countries – Italy, Greece, Egypt and Lebanon - like in most fisheries worldwide crew remuneration is paid by means of a crew-share system (Anderson, 1982, McConnell, K.; Price 2006, Guillen et al., 2017, Pinello and Dimech, 2013, FAO EastMed, 2014) where the main activity costs (e.g. fuel, food, ice, boxes, bait, etc.) are subtracted from the revenues and crew receives a share of gross returns (Griffin et al., 1979). Specific arrangements and adaptations vary by area and fishing fleet and depend also on the local habits and cultural peculiarities.

When analysing the cost structure in the eastern Mediterranean region (Table 10), what primarily stands out are the high energy costs for the Palestinian fishing fleet, which accounted for two-thirds of the total operational costs and which, due to the crew-share system, negatively affected the labour component which accounted only for 5 % of the total operational costs. For this reason, the Palestinian salary per fisher scored the lowest value in the region, slightly above the international poverty line (World Bank, 2017).

The Lebanese and Egyptian fleets had a more balanced cost structure with labour absorbing almost half of the operational costs while energy slightly exceeding one-fourth of the total. The reasons for the more balanced cost structure may result from the fact that in Lebanon the fishing stocks are only exploited by an artisanal fleet and that in Egypt fuel is heavily subsidized. Trawling was found to be the most energy consuming fishing technique and energy accounted for 39 % of the total operating costs. Subsidies may bias the weight of fuel costs in the total cost structure. This was the case in the Egyptian, Italian and Greek trawler fleet, where the fuel utilised by the fishing vessels is subsidized. The purse seine fleet had the lowest energy costs, about 21 % of the total operating costs, with the lowest value in the case of the Turkish fleet where the energy costs represented 17 % of the operating costs. In the small-scale fleet of the region labour represented about 50 % of the total operating costs, with the only exceptions for the Palestinian and Turkish fleets where labour was below 20 %. In Palestine, this was due to the fuel costs, which absorbed a large part of the share allocated to the salaries. The longliners were found to have high 'other costs', which represented about 40 % of the total operating costs. This cost category for this fleet segment was mainly represented by the costs for bait. For the Greek fleet this cost category represented 48 % of the total costs.

Table 10. Breakdown of the operating costs in percentage of the main fleet segments

	Egypt (%)	**Gaza (%)**	**Lebanon (%)**	**Turkey (%)**	**Cyprus (%)**	**Greece (%)**	**Italy (%)**	**Total region (%)**
Total fleet								
Labor costs	48	5	49	36	15	41	35	39
Energy costs	*29s*	66	26	*25s*	*27s*	*27s*	*36s*	27
*Other costs**	23	29	25	39	58	33	29	35
Total operating costs	100	100	100	100	100	100	100	100
Trawlers								
Labor costs	49	5		46		28	29	34
Energy costs	*31s*	69		*19s*		*40s*	*46s*	39
*Other costs**	20	26		35		32	25	27
Total operating costs	100	100		100		100	100	100
Purse seiners								
Labor costs	53	3	55	57		32	43	35
Energy costs	*21s*	62	23	*12s*		*20s*	*34s*	21
*Other costs**	26	35	21	31		49	23	44
Total operating costs	100	100	100	100		100	100	100
Small-scale vessels								
Labor costs	58	8	48	17		48	40	47
Energy costs	*22s*	64	26	*33s*		*24s*	*31s*	25

*Other costs**	20	28	26	51	28	29	27
Total operating costs	100	100	100	100	100	100	100
Longliners							
Labor costs	28				34	29	30
Energy costs	*37s*				*18s*	*31s*	30
*Other costs**	35				48	40	40
Total operating costs	100				100	100	100

**They include all the other intermediate inputs, such as maintenance costs, other activity costs and fixed costs and excluding energy;*
s = subsidized; In Egypt the fuel is generically subsidized for the whole economy, while in Cyprus, Italy, Greece and Turkey it subsidized only for specific economic sectors, such as the fishery sector.
Source: Pinello and Dimech, 2016

2.3.1 The extent of crew-share remuneration systems

Personnel costs, refer to remuneration where remuneration is payed through the crew-share system (Pinello et al., 2017). The crew-share system is, and has been throughout history, the most common way remuneration has been paid. In the crew-share system the crew receives a proportion of the gross returns (Zoeteweij, 1957; Griffin et al., 1979; Guillen et al., 2017; OECD, 2013). The proportion of the crew-share payments may be calculated based only on the gross returns, or it may be made as a “top up” above a fixed amount of above the minimum wage (Guillen et al., 2017). Reference to a crew-share scheme is made in Moby Dick, written by Herman Melville (Melville, 1851). Further, a study conducted by the International Labour Organization nearly 80 years ago (Sutinen, 1979) found that the share system was the dominant method of payment in fisheries in the countries they studied around the world. The use of crew-shares was described in detail along the Adriatic coast of Italy in the late 19th Century (Salvemini, 1897) and again in the 1950s (Salvemini, 1955).

More recent literature continues to suggest that crew-share systems have continued to be the dominant method of payment in fisheries and this is particularly the case in small-scale fisheries, as shown in Figure 7: globally and Australia (McConnell and Price, 2006);

Bangladesh (Mome, 2007); Bering Sea (Abbott, Garber-Yonts and Wilen, 2010); Brazil (Kalikoski and Vasconcellos, 2012); Chile (Salazar Espinoza, 2015); Egypt (FAO EastMed, 2014); Hawaii (Nguyen and Leung, 2009); Iceland (Matthiasson, 1997); India (Dhiju Das, Gopal and Edwin, 2012); Japan (Uchida and Baba, 2008); Lake Victoria (Reynolds and Greboval, 1988); Lebanon (Pinello and Dimech, 2013); New Zealand (Dewees, 1997); Oman (Al-Jabri et al., 2013); Senegal (Deme, 2012); Spain (Prellezoa and Iriondo, 2016); Thailand (Boonchuwongse and Dechboon, 2003); Viet Nam (Thuy, Flaaten and Anh, 2013); Ghana, Morocco, Senegal, Tunisia, Ecuador, Barbados, Mexico and Sweden (Guillen *et al.*, 2015).

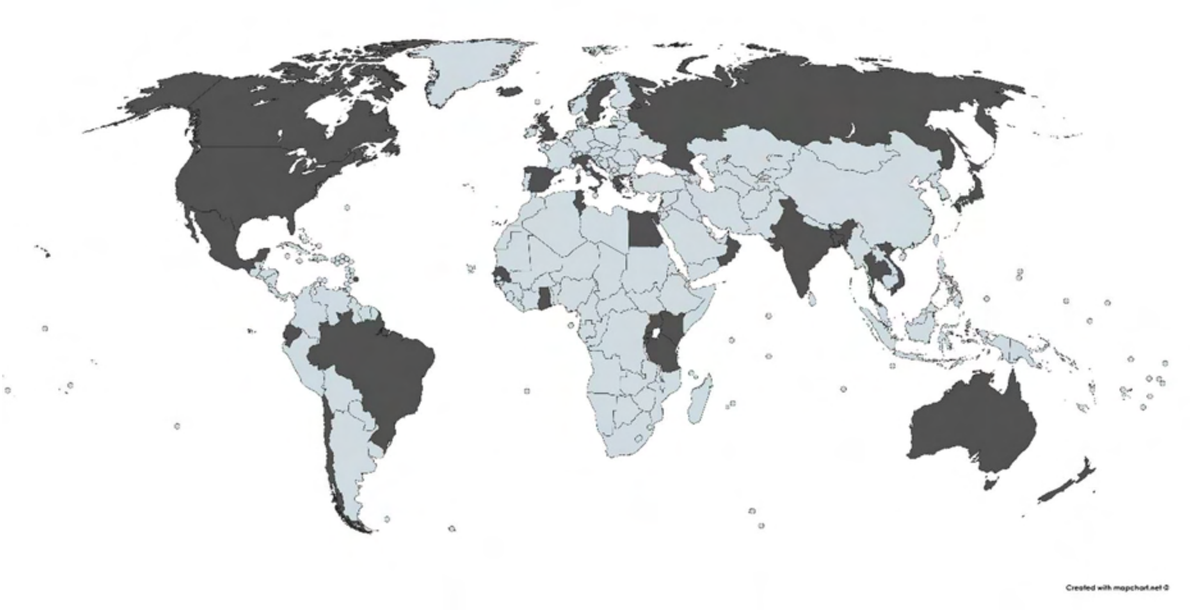

Figure 7. Distribution of reported use of crew-share system in fisheries around the world with countries identified in the literature shown in dark grey.
Map courtesy of www.mapchart.net.

The reporting on crew-share systems in the literatures is further supported by reporting in in the grey literature – such as online job fora[1] and discussion groups[2]– as well as experience in

[1] www.jobmonkey.com/alaska/getting_paid/

the field. The predominance of one of the forms of the crew-share system in fisheries contrasts with other industries where a variety of fixed wage systems, such as piece-work, bonuses and revenue or profit sharing systems (Matthiasson, 1997) are some of the many remuneration systems used. However, a trend towards the payment of fixed wages has been observed in cases where non-local fishers are employed in fisheries (Nguyen and Leung, 2009). This has also been observed in Europe over the past ten years (EU, 2006; Salz et al., 2006; EU, 2016b) where the increasing use of non-local labour has resulted in a shift away from crew-share based remuneration to wage or flat-rate remuneration. A large proportion (>80 %) of non-European labour working in European fisheries, was found to be engaged through contracts rather than crew-share systems (EU, 2016b). The shift observed in the EU was dually led by a decline in local labour availability and a desire to reduce labour costs (EU, 2006). A particularly worrying trend has been identified in some countries where fishing may be done outside of national waters employing non-local labour in order to avoid paying legislated minimum wages (Jones, 2017).

2.3.2 Limitations of remuneration data

When compiling socio-economic data on fisheries, remuneration is one of the main costs collected (World Bank and FAO, 2008; STECF, 2014). Because remuneration was typically classified as an input item and collected as a "personnel cost", it has been treated as an input item on the same basis as fuel or other activity costs (EU, 2010; EU, 2016a). It was also considered in the classical bio-economic models (Guillen et al., 2015) using the same definition. However, when a crew-share system, whereby the crew receives a share of the gross returns, rather than a fixed wage is in place, the system often does not allow for a conventional measure of remuneration (Grafton et al., 2006) and this makes it difficult to collect and accurately calculate information on remuneration. Crew-share payments may be

[2] https://www.facebook.com/groups/491305800985444/

based only on the gross returns, or they may be paid as a “top up” of a fixed minimum wage (Guillen et al 2017).

A further complication is that in small-scale fisheries the boat owners are frequently engaged in work on board a fishing vessel (Daurès et al., 2013; FAO EastMed, 2014; Thuy et al., 2013; Boncoeur et al., 2000; Guillen et al., 2015). This may confound reporting in the vessel or company financial statements (referred to here as “ledgers”) because some of the boat owner’s labour may be unpaid (Guillen et al., 2015). To make matters more complicated, many aspects of the fishing activity may be conducted informally, with transactions taking place outside formal markets (Schumann and Macinko, 2007) especially in small-scale fisheries (Guillen et al., 2015). Remuneration payments were usually made in the harbour or on board the vessels, with cash payments being typical (Firth, 2006). This is particularly true for small-scale fleets (Firth, 2006) and it is common that the payments would be made at the end of a fishing trip, or after a period of fishing activity, which may be aligned to a seasonal cycle (Georgianna and Shrader, 2005; Government of Mauritius, 2016). The fishing crews often received a small percentage of the catch for their consumption and skippers may receive a portion of the owner’s share as a bonus (Safran, 2009; Georgianna and Shrader, 2005). Further, in the case of the EU, vessels under ten meters were not obliged to keep logbooks nor to make landing declarations.

It was identified in the literature that underestimates of labour costs occurred within reported revenues (Van Iseghem et al., 2011) and these were likely to lead to the underestimation of crew remuneration as reported in the ledgers. This inaccuracy was further compounded by a general reluctance on the part of fishers and owners to report remuneration (Drupp et al., 2016). The outcome of this reluctance was that the values that were reported in the official data may have only reflected the minimum legal wage rather than actual wages paid. This is a global phenomenon and is not limited to the fishing sector (Carrillo et al., 2014).

All of these factors – the classification of remuneration as an input costs, issues with accuracy in reporting and calculating all limit efforts to gain insight into, among other considerations, the contribution that fishing makes to the livelihoods of people employed in the sector. When in place, crew-share systems allow all of the fishers to obtain a share of the rent (Sutinen, 1979) and this limits the extent of disparity on-board fishing vessels as all positions from skipper to deckhand are paid according to the same formula (Grafton et al., 2006) unlike in other contexts.

This section on crew-shares presents a novel method for calculating the remuneration of fishing crews in an indirect way, allowing the data to better capture the true nature of remuneration and thus improving data quality. Further, it is proposed as a novel indicator of economic performance since remuneration, under a crew-share system, is tied directly to the result of the fishing activity.

2.4. Labour related indicators

The indicators selected and utilized in this dissertation to analyse the whole spectrum of labour related, labour costs, socio-economic and livelihoods-related characteristics in fisheries include internal and external to the sector characteristics. In particular, internal characteristics include:

a) employment
b) remuneration
c) labour productivity
d) economic performance

Further, an external characteristic, equally important, is (e) the macroeconomic condition of the country or region where the fisheries are located. The macroeconomic condition contextualizes the contribution to livelihoods from fishing activity. These indicators are listed in detail below, including their meaning and their calculations as described in Gee et al. (2017):

(a) Employment in full-time equivalent (FTE)

Typically, labour inputs are measured in terms of hours worked, which are harmonized into a measure of FTE. This harmonisation allows for a standardization measure that can be compared across sectors, countries, etc. The threshold was set at 2000 h per year, an international level that can be considered as the standard unit of measurement for a full-time working position (IREPA et al., 2006; EC, 2005). Only crew working on board the vessel is accounted for within the FTE calculations and FTE can be considered a measure of labour intensity. The working hours of the crew also include the number of hours of work conducted onshore in support of the fishing activity, such as the time spent cleaning the net, preparing the catch, repairing the vessel, etc.

The harmonised FTE was calculated as follows: [(number of vessels per segment) × (average number of days at sea) × (average number of crew per vessel) × (average number of hours worked per crew member per day at sea)]/2000 h.

(b) Remuneration

It has been proposed that under the crew-share system remuneration can be regarded as an opportunity cost wage (Anderson, 1982; Griffin et al., 1989; Grafton et al., 2006).

Remuneration was considered on an annual basis and it was combined with employment to provide a tangible measure of the contribution that fishing makes to the livelihoods of the fishers, and an indicator of the overall economic performance of the activity. The value collected for remuneration included a figurative value for remuneration for any occurrence of the owner working on board the vessel. This figure included any occurrence of the owner working on board the vessel and so accounted for both the paid and the unpaid onboard labour of the owners.

Remuneration per fisher (FTE): remuneration values included the unpaid component of labour. This was particularly relevant for the small-scale fleets because owners and family members were engaged on board in the majority of cases. This allowed for a more homogeneous analysis between fisheries and between countries.

Remuneration per fisher/minimum wage of the country (REM): The minimum wage used in this study refers to the minimum wage in the manufacturing sector of each country, as estimated by the World Bank[3]. A national minimum wage was not available in all countries and the manufacturing minimum wage was selected because it best captured the reality of each national situation. It provided the most neutral and realistic benchmark for the region because the manufacturing sector requires similar skills to those required for fishing. The minimum wage for a full-time worker was obtained from The World Bank (2016) online database. This indicator was scored against a benchmark value of “1.0” which is equivalent to the value when remuneration per fisher is equal to the minimum wage.

This indicator was used as a measure of the attractiveness of the fisheries sector to the labour force. The minimum wage of the country provides an indication of this attractiveness and also provides a good reflection of the political and socio-economic conditions in each country. However, this indicator is limited by the fact that it does not capture the seasonal nature of fisheries work.

The *employment* on board was calculated in terms of harmonised FTE, using the same threshold for each country.

(c) Labour productivity (LP)

The measure of productivity for fisheries used here was the ratio of the output per unit of labour, measured as FTE. The standard theory states that LP reflects the technology utilized for the fishing activity together with the motivation and skills of the fishers involved (OECD, 2008). Typically, within economic theories, increases in LP have been viewed as positive outcomes. Increases can either be made by increasing the output of revenues less costs (numerator) relative to the denominator, or by decreasing the denominator (labour) relative to the numerator.

LP is a measure of productivity taken from the ratio of the output per unit of (input) FTE labour. *The GVA values were adjusted for PPP.*

LP was calculated as: GVA/FTE. See GVA below in d.

The FTE calculation takes into account the hours worked and the number of persons employed (head count). The productivity calculated in this way captures the use of the labour input better than productivity calculated only based on the number of persons employed (OECD, 2016).

Performance indicators:

(d) GVA/vessel (PPP)

The net output of fisheries after deducting intermediate inputs from all outputs reported per vessel. GVA shows the portion of revenues directed to remuneration, profit, opportunity cost and depreciation.

GVA/vessel was measured as: revenues − (energy costs + repair + maintenance costs + other operational costs + commercial costs + fixed costs).

Macroeconomic indicators:

(e) Minimum wage (PPP)

The minimum wage of the manufacturing sector, (current USD) as reported by the World Bank.

(f) GDP per capita (PPP)

Gross domestic product (GDP) at market prices is the expenditure on final goods and services minus imports: final consumption expenditures, gross capital formation and exports less imports (OECD, 2017). Fishers in nations with higher GDP values typically have access to more efficient technology, resulting in increased mechanisation (Panayotou, 1982; Fagerberg, 1987). For example, the labour productivity in the new member states of the European Union (EU) is about 25 % of that of the EU—25 average (Salz et al., 2006).

2.5. Overview

This chapter has presented a description of the fisheries, moving from a global overview into the specific study region. The primary socio-economic indicators were described in detail and then a summary of the cost-structure for the fishing fleets of the Mediterranean was included. Finally, both the internal and external labour-related indicators important for the fisheries sector were highlighted.

Globally, there were an estimated 39.4 million fishers operating in all environments and 3.2 million fishing vessels operating in marine waters. In the Mediterranean there were 93 000 fishing vessels with 221 797 fishers engaged in the primary sector. In 2012, the total estimated capture production was 79.7 million metric tonnes, and, in the Mediterranean, it was approximately 1.2 million metric tonnes. In 2012, 54 % of the total, or 136 million metric tonnes were traded.

The chapter highlighted the importance, in terms of economics and employment generation from the fishing sector around the world. The study area encompassed very diverse countries, in terms of macroeconomic conditions, that operated in the same body of water and so the comparison conducted in the analysis was more meaningful.

A suite of socio-economic indicators was utilised with the aim of assessing: economic performance and cost structure; livelihoods and employment; profitability; level of investments, debts and subsidies; and activity levels. The socio-economic indicators identified here are critical for the formulation and implementation of management plans that better account for the contribution to livelihoods in an evaluation of fisheries performance.

The cost structure characterizes the fishing segments and is an important component in the analysis of fisheries. Labour makes up the main component of costs, and together with energy costs account for more than sixty % of the total operating costs for fishing vessels. Some fleets in the study area had more balanced costs as mostly influenced by fuel costs, particularly under the application of fuel subsidies, and labour costs are based on a set proportion under the crew-share system. The crew-share system is commonly applied around the world and has been applied for at least the last three centuries (Sutinen, 1979; Selvemini 1897, 1955). Under this system the crew receives a share of the gross returns at a set rate.

The indicators used for the dissertation were selected to cover the whole labour-related spectrum including, labour costs, socio-economic and livelihoods. Both internal and external characteristics specific to the fisheries were included to address:

a) employment

b) remuneration

c) labour productivity

d) performance

e) macroeconomic conditions

CHAPTER 3: METHODOLOGY AND DATA

3.0 Introduction

Usually, when conducting research, the conclusions are based on 'evidence'. But what is the 'evidence'? In most of the cases, it is the product of a series of arguments and considerations which are based on information collected through an organized, structured, replicable and statistically sound method (Sapsford and Jupp, 2006).

Sampling is an application of statistical theory that relies on basic laws of probability to make inferences about a population, on the basis of a subgroup of that same population. Sampling theory involves more than a selection process. The overall sampling framework includes: defining the target population; the frame (or frames); choosing the sampling unit and associated reporting units; determining the sample size; developing a selection procedure; preparing the estimators and sampling error measures consistent with the sample design; implementing statistical controls for detecting and correcting non-sampling errors. Each of these design elements is dependent on other choices made (GSARS, 2015). Quantitative analyses can be based on this collected data and this is largely done in this dissertation by making use of indictors. These indicators could be either composed of single or composite variables. Here, indicators are defined as "variables, pointers or indices related to a criterion" (FAO 1999). They can be easily compared against reference points to reveal variations of performance for critical socio-economic elements of fisheries.

This chapter has been divided in two sections that both cover both theory and the practical application. The first section, A) Data collection and structure, is used to feed into the second section, B) Analysis. The first section discusses the theory behind survey sampling, sets consistent and coherent variable definitions as well as describes the practical application of surveys and the subsequent application of empirical tools. The understanding and control of the definitions and data collection process were important factors in improving the quality of data utilized in this dissertation. All of this is aimed at collecting the information that is useful for analyzing the efficiency and the socio-economic characteristics of fisheries to produce the data for analysis, covered in the second section.

A) Data collection and structure

The design of surveys for the collection of socio-economic data about fisheries is discussed under the context of data collection for the full spectrum of fishing fleets – from small-scale polyvalent to the largest trawl vessels. The focus is placed on the types of data to be collected in sample surveys, how to conduct the survey, collect, check and process the data, and finally calculate the indicators.

3.1 Sampling design

In order to obtain information about a population either a census or a survey, covering only a selection of the population, can be conducted.

A sample is a set of elements selected in some way from a population. The objective of sample surveys is mainly to make inferences about a population from information contained in a sample selected from that population (Sapsford and Jupp, 2006; Scheaffer et al., 2012). The results of the sample survey are then used to estimate characteristics of the entire population (Levine et al., 2008; Dorofeev and Grant, 2006).

The main benefit of choosing a sample approach over a census are the following (Levine et al., 2008; Tarkoma, 2013):

- Selecting a sample is less time-consuming than selecting every item in the population.
- Selecting a sample is less costly than selecting every item in the population.
- An analysis of a sample is less cumbersome and more practical than an analysis of the entire population.

- Selecting a sample guarantees better control of the data collection process and the quality of the data.

A mix of strategies are used in national contexts depending on many factors with the full spectrum of data collection techniques from administrative data to sample surveys to complete enumeration through census all being deployed. For example, when collecting information on sectors such as industry, construction, and distribution trade and services, the national statistical offices can follow different strategies (Snijkers et al., 2013).

- In the United Kingdom information is collected through an annual sample survey, with the frame updates through the statistical business register (number of enterprises).
- In the United States information is collected through an annual census of the number of enterprises and establishment of manufacturers and services.
- In the Netherlands information is collected through a blended sample survey plus administrative data, with updates from the statistical business register (number of enterprises).
- In Norway information is collected through a mixed strategy that includes numerous sources, including annual sample surveys, annual company accounts, the value-added tax register, and an annual census on the business register.

The sampling considered in the dissertation deals with a finite population and with a finite number of characteristics or parameters. Each sample extracted from the population contains a certain amount of information about the population parameter or parameters of interest. Because information 'costs', in terms of both money and/or effort, in the planning phase of a survey the amount of information, or the number of variables, that are to be collected have to be carefully determined. Too little information doesn't allow for good estimates, whereas too much results in a waste of effort and resources (Scheaffer et al., 2012; Sapsford and Jupp, 2006; Levine et al., 2008; Cochrane, 1977; Lohr, 1999). The quantity of information obtained depends therefore on the number of samples, the number of variables and on the amount of variation in the data (Scheaffer *et al*., 2012; Sapsford and Jupp, 2006). The variation in the data can be determined by the method chosen for selecting the sample and by the dimension of the sample, or the sample size.

The inference is in the form of an estimate of a population parameter, such as a mean (such as mean fuel consumption per fishing vessel), total (such as total employment), or proportion (such as proportion of product sold through the auction market), with a bound on the error of estimation (Scheaffer et al., 2012).

3.2 Population and sampling

3.2.1 Defining the population to be sampled

The first step in sampling is to define the population of interest clearly, accurately and in a way that each element of the population can be uniquely identified. The population, sometimes referred to as the universe (U), is therefore the sum of all the elements about which the researcher wants to draw conclusion and that our sample is to represent (Levine et al., 2008; Dorofeev and Grant, 2006).

In mathematical terms, it can be represented considering N as a known number of units, each with an assignable identifying label 1, 2, ..., N and bearing values, respectively, Y1, Y2, ..., YN of a valued variable y, which are initially unknown and are to be estimated. The total is then:

$$Y = \sum_{1}^{N} Yi \qquad (3.1)$$

and the mean:

$$\bar{Y} = Y/N \qquad (3.2)$$

The population is then the sequence *U* = (1, ..., N) of labels (Chaudhuri and Stenger, 2005).

The population can be *finite*, where all its units are countable (although its size, N, may be very large), or *infinite*, in the cases where it's not possible to count all the elements belonging to the population (Scheaffer et al., 2012).

The population should be completely defined in all its elements before starting the sample survey (Scheaffer et al., 2012; Sapsford and Jupp, 2006, Phillips and Stawarski, 2008). In the context of fisheries work the total population size will never be infinite and so the potential of working with a known population always exists.

In the case of this dissertation, the population is represented by all fishing vessel authorized to operate in the countries under investigation, and therefore it is a finite population. Each vessel bore a registration number, had specific characteristics, such as gross tonnage, length overall and construction year.

3.2.2 Sampling units

The sampling units are all the elements of the population that cover the entire population, in other words, populations can be thought of as consisting of sampling units (Scheaffer et al., 2012; Sapsford and Jupp, 2006). Each sampling unit must contain one and only one element of the population, which is uniquely identified, thus making them non-overlapping. Issues have been highlighted in the literature when the sampling unit contain more elements of the population, for example if in a household survey the sampling unit is the household, but the elements of the population are individuals (Scheaffer et al., 2012).

3.2.3 Sampling frame

A sampling frame is the set of source materials from which the sample is selected. It is the basis for identifying samples to be drawn from the population (GSARS, 2015). When the survey is set up, the sampling units are then organized under the sampling frame and each sampling unit could contain many elements. Whatever the circumstances, the sampling frame provides access to the individual elements of the population under study, either via sampling units, or directly when these and the population elements are identical (for example, where we are sampling people from a finite population and we have a complete list of the names of the population). The sampling frame could be anything at all if it exhausts the total population. Such lists and records will always contain mistakes, but they may be the only method of finding the sample elements so that the population can be surveyed (Sapsford and Jupp, 2006).

3.2.4 Selecting the sample

The objective will be to obtain estimates of population parameters, and some methods will do this more accurately than others. The choice of method will be a question of balancing accuracy against cost and feasibility. Two are the main methods of sampling: probabilistic sampling and non-probabilistic sampling. Probabilistic sampling includes *simple random sampling*, *stratified random sampling* and, if selection is at least in part random, *cluster sampling*. Non-probabilistic sampling, sometimes called purposive, includes *quota sampling* and ‘opportunity’ sampling: the simple expedient of using as a sample whoever is available and willing (Sapsford and Jupp, 2006).

Probability samples have considerable advantages over all other forms of sampling. All samples will differ to some extent from the population parameters, i.e. they will be subject to sampling error and very accurate estimates can be given of the likely range of this error, even though the population value will obviously not be known. This involves a fundamental statistical process, the randomization of error variation. Because randomization is missing from non-probabilistic methods, they have no such advantage (Sapsford and Jupp, 2006).

3.2.4.1 Simple random sampling

Simple random sampling is the fundamental and the most straightforward probability sampling strategy. Random sampling means that every element in the population of interest has an equal and independent chance of being chosen, that means that the selection of one element in not influenced by the selection of any other (Sapsford and Jupp, 2006; Gravetter and Forzano, 2011; Snijkers et al., 2013). Although it is called 'Simple', it is not easier to carry out than other methods, but that steps are taken to ensure that nothing influences selection each time a choice is made, other than chance. In fact, if it is correctly applied, it removes bias from the selection procedure and will result in representative samples (Gravetter and Forzano, 2011).

Random sampling is usually one of the most favorite method used in research due to the representativeness of sample group and the quality of the results when compared to non-random sampling techniques. However, it has some constraints, the most important of which is the detailed knowledge of the population and a large sample size (Gravetter and Forzano, 2011; Snijkers et al., 2013).

In theory, it should require the selection of samples with replacement, where any element selected should have a chance of being selected again, avoiding that the probability of being selected would change each time an element was removed from the sampling frame and placed in the sample. In practice, when the population is only sampled once per survey period, there is no opportunity for the same sample to be selected twice. This negates the effect of non-replacement and the need for a large sample size (Sapsford and Jupp, 2006; Gravetter and Forzano, 2011).

The random selection of the samples has to be done following precise rules, and the outcome is similar to tossing a coin. It is worth reinforcing the point that the selection must be truly random – not based on a human interpretation of a random event like a coin toss as, has been well established, people are extraordinarily incapable of making random choices. Even an understanding of human bias is often not enough to overcome it influencing choices. Neither haphazard methods nor someone deciding they can 'overcome' their bias will lead to an unbiased, or random, selection (Sapsford and Jupp, 2006).

3.2.4.2 Stratified random sampling

Stratified sampling is the most commonly used sampling technique for business surveys. A stratum, or segment, is a subset of the population where the elements have common attributes. To stratify the population then means to partition the population into non-overlapping strata, on the basis of some common attributes, in order to have each element of the population categorized in one of the strata (Cochran, 1977; Sapsford and Jupp, 2006; Scheaffer et al., 2012; Snijkers et al., 2013). The sample size can be proportionate or disproportionate to the population size. In a disproportionate stratified random sampling technique, the proportion of sample of each stratum is the same as in the population, while, on the contrary, in disproportionate stratified random sampling, the sample size is disproportionately large to ensure that all strata of the population are adequately represented (Cochran, 1977; Sapsford and Jupp, 2006; Scheaffer et al., 2012; Snijkers et al., 2013). In disproportionate stratified random sampling the sample doesn't match the population, but the difference can be corrected arithmetically and, it is avoided that small strata will not be represented adequately in the final sample (Sapsford and Jupp, 2006).

Once the population has been portioned into different and separate strata, the sampling within strata can be carried out independently (Sapsford and Jupp, 2006; Snijkers et al., 2013).

In general, optimal conditions for stratification are considered the following (Cochran, 1977; Sapsford and Jupp, 2006):

1. When elements in the population have widely varying sizes and there is a good source of size information with which to construct the strata

2. When elements within a stratum are more alike in terms of the outcome variable, than to elements in other strata, that is, when the strata are homogeneous (or equivalently, when the variables on which the stratification is built are good predictors of the outcome variable as measured in the survey).

In general, stratification provides many advantages, for example, money is saved by reduction in sample size and reduction of fieldwork costs, such as time, travel, interviewer and administration fees, and the printing and processing of questionnaires (Sapsford and Jupp, 2006).

The following are the main steps followed when developing a stratified design (Sapsford and Jupp, 2006):

- Choose the variable(s) that will be used for determining strata.
- Determine the boundaries between strata.
- Determine the sample size for each stratum.

3.2.4.3 Clustering and the preparation of the target population

Once all the individual vessels have been classified according to their geographic, technical and dimensional characteristics the target population was shown through the lens of the categories. In cases where segments contained very low numbers of vessels they were merged with their nearest neighbour in order to avoid issues of low response rates and to maintain a certain level of confidentiality. In the cases where segments contained fewer than ten vessels they were merged with the nearest neighbour.

3.3 Variables to be collected

The first data to be collected in a fishery monitoring programme are often catch or landings data. Starting with the catch or landings data is logical because the fish landed are tangible, discrete entities that can even be counted one-by-one. On the contrary, most of the variables collected in socio-economic surveys are less tangible and this naturally increases the difficulty of collecting these data.

In traditional data collection, paper questionnaires are used to collect survey data. The questionnaire contains the variables to be collected and the questions to be asked in order to obtain the variables.

Socio-economic data collection focuses on the inputs used, the amount of fish harvested, the interaction with the market and the benefits and returns to those engaged in the activities.

The data used in this study were collected through face-to-face interviews by trained data collectors with specifically designed questionnaires. The variables included in the questionnaires are detailed in the following section.

Utilizing a structured questionnaire, the variable collected were structured into thematic categories. In each of the thematic contained two levels of hierarchy: variable and microvariable. The thematic categories were:

Part A: Administrative information

Part B: Source of the information

Part C: Ownership

Part D: Effort

Part E: Employment

Part F: Commercial (destination of the first sale)

Part G: Variable costs

Part H: Fixed costs

Part I: Investments

Part J: Debts and subsidies

Part K: Income

Table 11 provides a summary of the typical variables included in each part of the questionnaire. The groups of variables referring to effort and income, were also collected in pre-existing catch and effort surveys in the case of Greece and Italy, while for Egypt and Lebanon these variables were collected under the socio-economic survey. These additional variables had two utilities: First, they provide a reference for cross-checking the primary information. Second, the final estimates from these variables provide reference points for calibrating the data being collected and are of interest to the overall data collection and statistical programmes that are already in place.

Table 11. Summary of the variables included in the questionnaire

A) ADMINISTRATIVE INFORMATION
Code of the vessel
Date of the interview
Reference period
B) SOURCE OF INFORMATION
Owner
Partner

	Skipper
	Fisher
C) OWNERSHIP	
	Owner engaged on the vessel
	Owner engaged in the activity of the vessel
	Owner's sole occupation engagement
	Is fishing the main source of income for the owner
D) EFFORT	
	Number of fishing trips
	Average duration of a trip (hours)
	Days at sea
	Average hours at sea (daily average on a 24-hours basis)
	Average time actively fishing in hours (daily average on a 24-hours basis)
	Gears used
	Working hours onshore (daily average on a 24-hours basis)
E) EMPLOYMENT	
	Engaged crew per vessel – daily average (including owner)
	Number of different individuals working on the vessel (including owner)
	Number of people engaged in on-shore activities
	Number of different individuals engaged in on-shore activities
F) COMMERCIAL (DESTINATION OF THE FIRST SALE)	
	Wholesaler
	Auction
	Exporter
	Processing industry

Fishmonger
Direct selling to the final customer
Direct selling to the restaurant
Self-consumption

G) VARIABLE COSTS

Energy costs

Fuel type
Fuel costs
Fuel consumption (litres)
Lubricant costs
Lubricant consumption (litres)
Fuel price

Personnel costs

Remuneration of crew (including owner)
Remuneration of crew (excluding owner)
Average daily remuneration of one fisher (the basic fisher)
Social security, social costs and pension contribution per fisher
Crewmember insurance per fisher

Other operational costs

Purchase of food
Purchase of bait
Purchase of other consumable materials
Cost of truck required for vessel operations
Other operational costs

Repair and maintenance costs

	Maintenance and repairs to vessel
	Maintenance and repairs to engine
	Maintenance and repairs to on-board machineries
	Maintenance and repairs to gear
	Maintenance and repairs to truck
	Other repair and maintenance costs
H)	**FIXED COSTS**
	Book-keeping
	Vessel insurance
	Maintenance and repairs to on-board machineries
	Legal expenses
	Bank costs
	Fishing licence renewal (vessel)
	Other fixed costs
I)	**INVESTMENTS**
	Purchase of engine
	Purchase of fishing gears
	Purchase of equipment (mechanical, hydraulic, electrical equipment)
	Purchase of truck
	Other investments
	Current market value of vessel
	Current market value of the fishing licence and/or the fishing rights
J)	**DEBTS AND SUBSIDIES**
	Loan taken in relation to the fishing activity
	% of the asset covered by the loan

	Direct monetary subsidies received
K) INCOME	
	Revenue obtained by using the vessel for activities other than fishing
	Total quantity of fish landed by group of species
	Total value of fish landed by group of species

In this questionnaire, the variables were provided in a rational sequence that was followed during questionnaire delivery. The explanations and responses for the questions built on the previous items and allowed the interview to begin with the less sensitive questions and build towards an increasing degree of complexity required for the responses.

Variables and microvariables

Part A: Administrative information

- Code of the vessel: system generated and stays with the vessel throughout the year.
- Date of the interview: the date on which the interview is actually conducted.
- Reference period: the number of the week or month during which the questionnaire is deployed.

Part B: Source of the information

01. Source of information: whether the owner; partner; skipper or fisher is responding to the questionnaire.

Part C: Ownership

Owner: these distinctions between levels of engagement are important. In some studies, the efficiency of vessels where the owner was engaged in vessel operations was found to be higher than for those without owner-engagement (Pinello et al., 2016).

02. Owner engaged onboard the vessel: yes, if the owner worked on the vessel during fishing activity.
03. Owner engaged in the on-shore activity of the vessel: yes, if the owner was engaged on-shore.
04. Owner's sole occupation is engagement in fishing: yes, if the owner was only engaged in fishing and no other activities in any other sectors.
05. If NO to (04), is fishing the main source of income for the owner? Yes, if the owner was engaged in other sectors, but still receives the greatest proportion of their income from fishing.

Part D: Effort

06. Number of fishing trips: the number of fishing trips conducted during the interview period. The fishing trip was defined as any voyage by a fishing vessel from a land location to a landing place and excluded non-fishing trips.
07. Average duration of a fishing trip (hours): the number of hours, on average, a fishing trip lasted during the interview period.
08. Days at sea: any continuous period of 24 hours (or part thereof) during which a vessel was at sea during the interview period.
09. Average hours at sea (daily avg. on 24-hours basis): in any 24-hour period the amount of time spent deploying/hauling/running for fishing activities.

10. Gears used: for every gear used during a fishing trip, the number of days or hours each gear was used. This variable allows for a more precise identification of the amount of time spent fishing with each gear type.
    In the case of passive gear, soaking time was not included in the calculation of time the gear is used.

Part E: Employment

11. Engaged crew per vessel (including owner): the total number of engaged crew per vessel, daily average including the owner, if present. This number will reflect the number of working positions on the vessel (e.g. skipper and two crew members).
12. Number of different individuals working on the vessel (including owner): number of different individuals working on the vessel regardless of the number of positions they may occupy; all people engaged throughout the interview period.
13. Working hours onboard (daily avg. per crew member on 24-hours basis): any time on board the vessel that the crew is required to do work, including fishing activity, but also any other activities like cleaning, repair and maintenance.
14. Number of people engaged in onshore activities: all people engaged in onshore activities related to the vessel (e.g. cleaning nets, repairing the gears, preparing the bait, sorting fish for the market, etc.). Usually, the majority of them are the same onboard crew members.
15. Number of different individuals engaged in onshore activities: the total of all people engaged in onshore activities related to the vessel throughout the interview period.
16. Working hours onshore (daily avg. on 24-hours basis): the average number of hours of work conducted onshore in support of the fishing activity.

Part F: Commercial (destination of the first sale)

17. Commercial (destination of the first sale): this percentage of the first commercial step of the fish from the vessel (ex-vessel) to the first buyer (e.g. wholesaler, auction, exporter, processing industry, fishmonger, final consumer, restaurant).
18. Self-consumption: the part of the production that is not sold commercially but is distributed amongst the crew members.

Part G: Variable costs

The variable costs were composed of:

- energy costs
- personnel costs
- other operational costs
- commercial costs
- repair and maintenance costs.

Energy costs

19. Fuel type: the fuel used for the main engine of the vessel (petrol vs. diesel).
20. Fuel cost: the total cost for the interview period of all of the fuel consumed by all onboard vessel activities (main engine, secondary engine, generators, machinery used onboard).
21. Fuel consumption: the total amount of fuel consumed for the interview period by all onboard vessel activities (main engine, secondary engine, generators, machinery used on board).

22. Lubricant cost: the total cost for the interview period of the lubricant used by all onboard vessel activities (main engine, secondary engine, generators, machinery used on board).
23. Lubricant consumption: The total cost for the interview period of all of the lubricants consumed by all onboard vessel activities (main engine, secondary engine, generators, machinery used on board).
24. Fuel price: The weighted average (if the price of fuel changed over the interview period then this can be derived from the total cost divided by the total volume).

Personnel costs

Personnel costs form the most important group of variables – in socio-economic terms. Crew compensation is made on a *share* basis in many cases, which means the greater the value of the catch landed, the more money each crew member gets as a share of the total. The *share* is usually calculated as a percentage of revenue, or revenue minus certain categories of cost and the exact formula used for the compensation of the fishers was queried.

25. Remuneration of crew, including owner: the total remuneration includes social security costs for all crew members *including* the owner. This is often the same value as that reflected on the official payslips.

26. Remuneration of crew, excluding owner: the total remuneration includes social security costs for the crew, *excluding* the owner. This is often the same value as that reflected on the official payslips.

27. Remuneration based on a fixed amount: yes/no, if no proceed below:

select which of the following formulas are used for the calculation of the remuneration:

a) percentage of revenue: in this case, the crew receives a set percentage of the revenue no matter the costs associated with the fishing trip [e.g. "one-third of the revenues"].

b) [= revenue – fuel]: only fuel costs are discounted from the revenue.

c) [= revenue – fuel – food]: fuel costs and food costs are discounted from the revenue.

d) [= revenue – fuel – food – bait]: fuel, food and bait costs are discounted from the revenue.

e) [= revenue – fuel – food – bait – commercial costs]: fuel, food, bait and any commercial costs (e.g. ice, boxes, fish market commission, etc.) are discounted from the revenue.

f) [= revenue – fuel – food – commercial costs]: fuel, food and any commercial costs (e.g. ice, boxes, fish market commission, etc.) are discounted from the revenue.

g) other (specify)

percentage that goes to the crew: If b, c, d, e and f selected, then from the calculation what percentage goes to the crew? After any costs (as seen in b, c, d, e, f) are discounted from the revenue, this is the percentage share that goes to the crew.

28. Average daily remuneration of one fisher: The general average for fishers of a certain segment in a specific port. This value is not the average for a specific fisher on a single vessel. Typically, this reflects the day rate for a fisher if they are paid under that system.

29. Social security, social costs and pension contributions per fisher: the portion of remuneration that is required by law to be paid for items such as pension for an average crew member.

a) Number of crew participating in social security scheme: the total number of crew members who received a form of social security, social costs and/or pension contributions per fisher.

30. Crew member insurance per fisher: the cost of insurance paid for an average crew member.

a) Number of crew covered by insurance: the total number of crew members who received item 30.

Other operational costs

This variable group included all of the purchased consumable inputs relate directly or indirectly to fishing effort.

31. Purchasing food: the cost of food purchased for all of the crew.

32. Purchasing bait: the cost of bait purchased.

33. Purchasing other consumable materials: the cost of the purchase of items such as lightbulbs, batteries, etc.

34. Cost for other services required for vessel operations: this item refers to the costs associated with other services related to the vessel operation (for example, the cost for the truck that hauls the boats out of the water at the end of a fishing operation).

35. Other operational costs: any items that do not fit into the previous microvariables.

Commercial costs

All the costs related to selling the production resulting from the activity of the vessel.

36. Fish market commission (as a percentage of the revenues or monetary value): the transaction cost paid to the fish market or middleman for selling the product.

37. Transportation of the fishing production (from vessel to place of selling): the cost for transportation from the vessel to the first point of sale.

38. Purchasing ice: the cost of ice purchased.

39. Purchasing boxes and packaging: the cost of any boxes and packaging purchased.

40. Other commercial costs: any items that do not fit into the previous microvariables.

Repair and maintenance costs

The costs for vessel and gear maintenance and repairs, whether routine or extraordinary costs.

41. Maintenance and repairs to vessel: the cost of any repairs or maintenance for the vessel.

42. Maintenance and repairs to engines: the cost of any repairs or maintenance for the engines.

43. Maintenance and repairs to onboard machinery: The cost of any repairs or maintenance for any onboard machinery, e.g. winches.

44. Maintenance and repairs to fishing gears: the cost of any repairs to or maintenance of all fishing gears.

45. Other repair and maintenance costs: any items that does not fit into the previous microvariables.

Part H: Fixed costs

These variables included the costs which were not directly connected with operational activities (effort and catch/landings) for the vessel, no matter the activity level.

46. Bookkeeping (e.g. accountant): the cost for the accounting activity.

47. Vessel insurance: the cost of insurance for the vessel.

48. Legal expenses: the cost of the use of a lawyer or legal service

49. Bank costs: the cost of any banking related services (related to the vessel).

50. Fishing licence renewal (vessel and fisher): the cost of renewing a fishing licence for the fisher and/or vessel.

51. Other fixed costs: any items that do not fit into the previous microvariables.

Part I: Investments

Improvements to a vessel/gear aim to improve the "lifetime" of the assets but are not consumed within the given year.

52. Purchase of engines: the cost of engines purchased.

53. Purchase of fishing gears: the cost of fishing gears purchased.

54. Purchase of equipment (mechanical, hydraulic, electrical equipment): the cost of equipment purchased (for example, winches, generators, radios, GPS, etc.)

55. Other investments: the cost of other items purchased (for example, fish storage boxes).

56. Current market value of the vessel (excluding licence): the price that would be obtained if the vessel were to be bought – the current replacement price (without the licence).

57. Current market value of the vessel (including licence): the price that would be obtained if the vessel were to be bought – the current replacement price (with the licence).

58. Current market value of the fishing licence and/or the fishing rights: the price that would be obtained if the licence or fishing rights were to be sold – the current replacement price.

Part J: Debts and subsidies

Items 59 to 61 pertain to measuring the level and source of indebtedness of the vessel and the general ability to access credit.

59. Were any loans taken in relation to any aspect of the fishery activity (yes/no): whether any loans were taken out for any aspect related to fishery activity during the interview period.

60. If yes to 59, specify the source: a) bank; b) company; c) buyer; d) other.

61. percentage of asset covered by the loan: the assets referred to here are those from items 52 to 57 (investments in physical assets) and the loan can be any amount owing from any prior period.

62. Direct monetary subsidies received: the total amount of direct monetary subsidies received from the government, either for the activity or for the investments.

Part K: Income

The total income comes from fishing activities as well as other non-fishery uses of the vessel, although the primary output of the fishing activities is the capture of species.

63. Revenue obtained by using the vessel for activities other than fishing: whether the vessel is used for activities such as tourist trips, rental as an aquaculture support boat, or by leasing the quota or fishing rights.

64. Total quantity of fish landed by group of species: total amount of fish landed by species group reported in either weight or proportion of total catch.

65. Total value of fish landed by group of species: this pertains to the total value of fish landed and can then be further broken down by the species groups landed.

3.4 Quality control of the data

The step which precedes the exercise of making estimations for the total populations based on the sample is the assessment of the data quality and any necessary adjustment to the data made. Generally, the two forms of error which can be distinguished in a sample survey are sampling and non-sampling errors.

3.4.1 Errors, sample size and non-response

In general terms, error is used to describe the difference between an estimated value and the actual value in the population and then this can provide an estimate of how well the sample represents the population (Chaudhuri and Stenger, 2005; Diez et al., 2012). The two categories of error in sample survey activities are *sampling error* and *non-sampling error*. Sampling errors only occur under sample surveys, not under a census as they are the result of factors outside of the sample selection (Sapsford and Jupp, 2006, Levine et al., 2008; Groves, 1989).

Further, sampling error can only be reliably estimated from the sample variation if the sample selection has been random, whereas non-sampling errors cannot be (Sapsford and Jupp, 2006; Scheaffer et al., 2012). For this reason, random sampling allows unbiased estimates of sampling error and, can be noted as in many cases, the standard error, i.e. an estimate of sampling error, is wrongly utilized as it is calculated for samples which have not been randomly collected (Sapsford and Jupp, 2006; Snijkers et al., 2013). This said, at least sampling error can be calculated and judgement on the reliability of the sample can be made (Sapsford and Jupp, 2006, Levine et al., 2008).

Non-sampling errors are the errors in the estimate resulting from all of the survey activities. These can include: poor coverage and selection bias, low response rates, non-responses, interviewer errors and data entry errors (Sapsford and Jupp, 2006) and are found in sample surveys as well as censuses and present a nearly impossible to detect and measure case which, can increase with increasing sample size (Pinello et al., 2017). Non-sampling errors can be limited and kept under control through the strict application of correct survey and questionnaire design plus the use of reliable data collectors who have been trained appropriately (Pinello et al., 2017).

A well planned and strictly implemented randomization helps to control potential sources of bias, both known and unknown (Sapsford and Jupp, 2006; Snijkers et al., 2013). In fact, if the error, whatever its source, is randomly distributed across a sample, it will be cancelled when the statistics are computed. A more problematic matter is the occurrence of systematic, non-random errors, which are not controlled in this way (Sapsford and Jupp, 2006; Phillips and Stawarski, 2008). Moreover, non-sampling error is often overlooked when survey findings are evaluated, and if an estimate of sampling error is given, then it is often wrongly assumed that this shows the likelihood of total error and, for all these reasons, non-sampling error should be avoided or limited as far as possible (Snijkers et al., 2013).

Although sampling and non-sampling errors refer to different entities and it is theoretically important to consider them as such, in practice it is never possible to obtain a true measure of sampling error. It is only possible to obtain an estimate of it, and the influence of non-sampling error is hopelessly confounded within that estimate (Sapsford and Jupp, 2006; Snijkers et al., 2013).

Formulas used to compute standard errors are based on the idea that the samples are taken from infinite populations or are selected with replacement. In many surveys these assumptions are not true, but they don't present big problems when the sample size, n, is much smaller than the population size, N. However, when the sample size is larger (usually more than 5 % of total population), is best to apply a correction to the formulas. This correction is known by the finite population correction or fpc (Moura 2016) and it is calculated as:

$$fpc= \sqrt{\frac{N-n}{N-1}} \tag{3.3}$$

The best statistical measure of sampling error is represented by the variance (e.g. coefficient of variation or standard error) (Sabatella and Franquesa, 2003). Sampling variance is the variability of a statistic over all possible samples collected using the same sample design. The keys to measuring sampling variance are randomization of the selection and replication of the methodology with the minimum condition required to measure it being that the unit belongs to the frame population and has a known and non-zero chance of be selected (Groves, 1989).

Variance is defined as the average of the squared differences from the mean.

$$VAR(\bar{X}) = \frac{\sum_{i=1}^{N} (x_i - \bar{x})^2}{N} \quad (3.4)$$

Where:

N = total population

n = sample size (number of samples)

$\bar{x}$ = is the mean value of the variable *x*

According to sampling theory, when the sample size n is not small relative to the population size, N (i.e., more than 5 % of the population is sampled), so that *n/N* > 0.05, a *finite population correction factor* is used. This correction factor, expressed as (*1 – n/N),* approaches zero as the sample size (*n*) approaches the population size (*N*). This follows a logical pathway because when *N* = *n*, the sample becomes a census and sampling error becomes moot (Groves, 1989; Pinello et al., 2017).

The estimation of the variance, including the correction factor, is expressed as the following, as modified according to De Meo (2013):

$$\widehat{VAR}(\bar{X}) = \frac{1}{n}\left(1 - \frac{n}{N}\right)\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1} \quad (3.5)$$

where:

N = total population

n = sample size (number of samples)

$\bar{x}$ = is the mean value of the variable x

Sample size

Sampling size controls sampling, with larger sample size that can reduce sampling errors (Sapsford and Jupp, 2006; Levine et al., 2008; Diez et al., 2012). The precision of final estimates depends very much on sample size and doesn't depend on the size of the population sampled (Sapsford and Jupp, 2006).

Neyman and the optimal allocations of sample units to strata

Within the field of stratified random sampling a set of rules have been defined for allocating the sample size efficiently among the strata. One of these rules – and one of the most commonly applied – is the "Neyman allocation" (Neyman, 1933). This rule utilizes a sample allocation method where the n sample elements are distributed among the strata in order to minimize the variance (VAR) of a sample estimate to a given total sample size. The allocation of sample units to a stratum I should be proportional to N_i S_i where N_i is the size of stratum i (the number of population units in the i^{th} stratum) and S_i is the population standard deviation in that stratum. This allocation then provides the optimal sample size for each stratum (n_i) (Lipsey, 1990; Sapsford and Jupp, 2006; Diez et al., 2012).

Non-response Errors

The primary bête noire for sample surveys is the matter of non-responses. Non-responses belong to the group of non-sampling errors, and together with wrong coverage rates, is an error of non-observation (Groves, 1989). Non-response is defined as the failure to obtain complete measurements of the survey sample.

Non-response errors affect survey results in two ways. First, they decrease the sample size, or the amount of information collected in response to a particular variable and this results in larger standard errors. The second affect is the introduction of bias resulting from the extent which the non-respondents differ from respondents within a selected sample (Statistics Canada, 1998). Re-stated, an uneven distribution of non-responses impact survey quality is affected. This said, non-response rate is not a measure of quality of a survey alone, although it may be mistakenly defined as such (Groves, 1989; Sapsford and Jupp, 2006; Snijkers et al., 2013).

Non-response can be separated into sample and variable non-response. “Sample non-response” is defined when it was not possible to collect any information from a sample while “Variable non-response” was defined when it was not possible to collect information for some variables of a sample. The dissertation focuses on sample non-response but offers a brief commentary on approaches to missing data at variable level (Groves, 1989; Diez et al., 2012) as this type of non-response was found to occur when the sample surveys considered here were conducted.

Usually sample non-response arise in three primary ways (Groves, 1989; Snijkers et al., 2013):

(1) unable to contact the sample;

(2) inability of the sample unit to provide responses to the survey; and

(3) refusal to participate in the interview request.

The rate of non-response is usually high in sample surveys. For example: non-response rates from the labor force survey conducted by The Netherlands Central Bureau of Statistics were found to range between 13 and 20 % in the 1970s (Bethlehem and Kersten, 1981) while for telephone surveys a non-response rate of about 39 % was reported (Wiseman and McDonald, 1979). Non-response causes both an increase in variance, due to the decrease in the effective sample size and/or due to the use of imputation and may cause bias if the non-respondents and respondents differ with respect to the characteristic of interest (Statistics Canada, 1998).

It would be anticipated that non-response rates vary because of sampling variability: the proportion of non-responses is expected to vary over samples selected with the same design (Groves, 1989; Snijkers et al., 2013). Another critical source of variability for non-response errors, and one that is well-understood by field managers of data collection programs but not readily quantified, is associated with data collectors (Cochran, 1977; Groves, 1989). Data collection through interviews requires a set of soft-skills that cannot be exactly quantified nor exactly replicated from person to person. These differences in performance remain even though all the data collectors might be given the same training, the same supervision, and the same workloads with similar mixes of cases and, thus, the amount of non-response bias in one survey is also function of which data collectors are chosen (Groves, 1989). In some cases, data collectors have difficulty gaining the cooperation of certain types of interviewees and obtain low response rates while others obtain high response rates (Groves, 1989; Snijkers et al., 2013). This source of potential bias is rarely reflected in statistical models, although very common (Groves, 1989). If a survey analyst is interested in estimating the level of bias in survey statistics, then the effect of data collectors as a source of variability in non-response error should be considered.

Statistical treatment of non-response in surveys: “double sampling” or “two-phase sampling”

Considerable attention has been placed by statisticians on bringing non-response issues under formal consideration in the context of sample survey (Groves, 1989; Chaudhuri and Stenger, 2005; Snijkers et al., 2013). The statistical treatment of non-responses has focused on the analysis of the characteristics of the non-responding portion of the sample to establish whether or not the two groups have different characteristics (Groves, 1989; Sapsford and Jupp, 2006; Snijkers et al., 2013). If the responding and non-responding groups of the sample are found to have the same characteristics, from statistical point of view, then the survey can proceed (albeit with a low response rate). However, if the characteristics of the two groups are different, then it becomes necessary to intervene to improve the response rate.

One of the most utilized interventions is the application of “double sampling” or “two-phase sampling”. Double sampling or two-phase sampling identifies a subsample of samples after the initial selection is made (Neyman, 1938). In the first phase a sample is selected and used in the initial data collection effort, while the second phase sample is drawn typically using information obtained in the first phase (Groves, 1989). This sampling design is appealing when considering the non-response problem because it offers a method of balancing both errors and survey costs in the decision on what efforts should be made to correct for non-responses (Groves, 1989; GSARS 2015). After the initial efforts are completed the second phase of the data collection operation commences with the drawing of a probability sample for the remaining non-responses. This is an expensive (but ideally wholly successful) methods of obtaining measures on the sample non-responses (Groves, 1989; Sapsford and Jupp, 2006; GSARS 2015). Since a probability sample of non-responses is drawn and then interviewed, it is used to estimate characteristics of all non-responses, and when it is combined with respondents from the first phase, survey statistics can be calculated without non-response bias. However, to eliminate non-response error, a complete measurement of the subsampled non-responses is required (Groves, 1989; Sapsford and Jupp, 2006) and the costs of contacting and persuading sample units to cooperate with an interview are not negligible. The sampling and non-response error of resulting statistics depend on the second phase sample design and the success rate of measuring all sampled non-responses (Groves, 1989). Moreover, it is worth noting that attempting to decrease one source of error may merely increase another. For example, the reduction of non-response achieved by aggressively persuading samples to cooperate may result in larger measurement errors in the survey data (Cochran, 1977; Groves, 1989).

In summary, the degree to which the errors can be reduced is also limited by practical constraints. In particular, the cost efficiency of a survey, defined as the relationship between quality (absence of errors) and costs limits how much money we can use on survey planning and implementation, and this naturally also limits the efforts we can use on minimizing errors (Snijkers et al., 2013).

The control procedures, described in Figure 8, below, and in the following section are the procedures undertaken to ensure the data are as error-free as possible. A step-wise process was followed for the data processing.

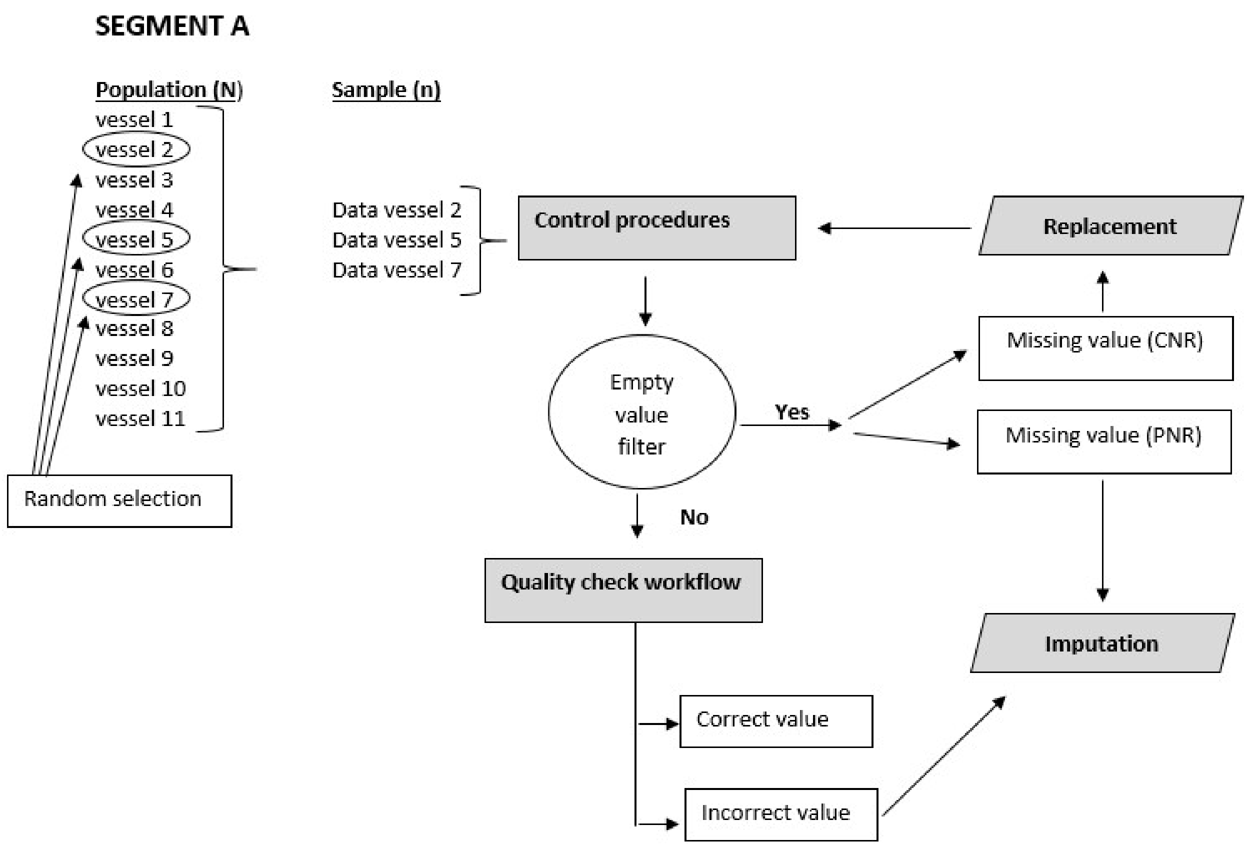

Figure 8. The two processes for the control procedures

Action 1. Organize the sample data by vessels with the microvariables both disaggregated and grouped into their respective variables (e.g. variable group "Energy cost" with all of the micro variables: fuel type; fuel – value of consumption; fuel – volume of consumption; lubricants − value of consumption; lubricants − volume of consumption; fuel price).

Action 2. Run a filter on the data to identify empty cells. Once the empty cells are separated you can proceed to step 3 with the non-empty values. See Step 4 for treatment of CNR missing values.

Action 3. Run the quality check workflow (as detailed in Figure 9) so that the incorrect values are identified and then selected for imputation (along with the missing values − PNR identified in Step 2).

Action 4. Missing values are either CNR or PNR. If CNR "replacement" may be used if necessary. See Figure 9 below for details.

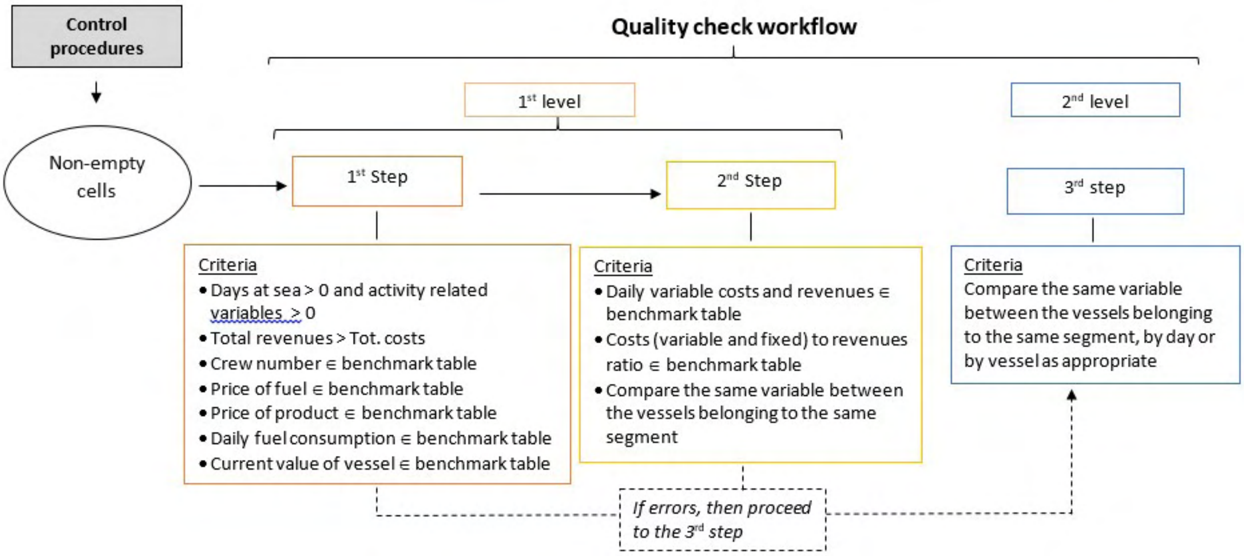

Figure 9. Details of the quality check workflow levels and steps

Replacement of missing values (CNR)

In cases where there were too many complete non-responses (CNR) and the response rate was deemed too low then replacement was used to obtain a higher response rate as in Figure 10. In using replacement, the "substitute" vessels were pulled from the subsequent next-in-sequence list of vessels identified in the random sampling procedure.

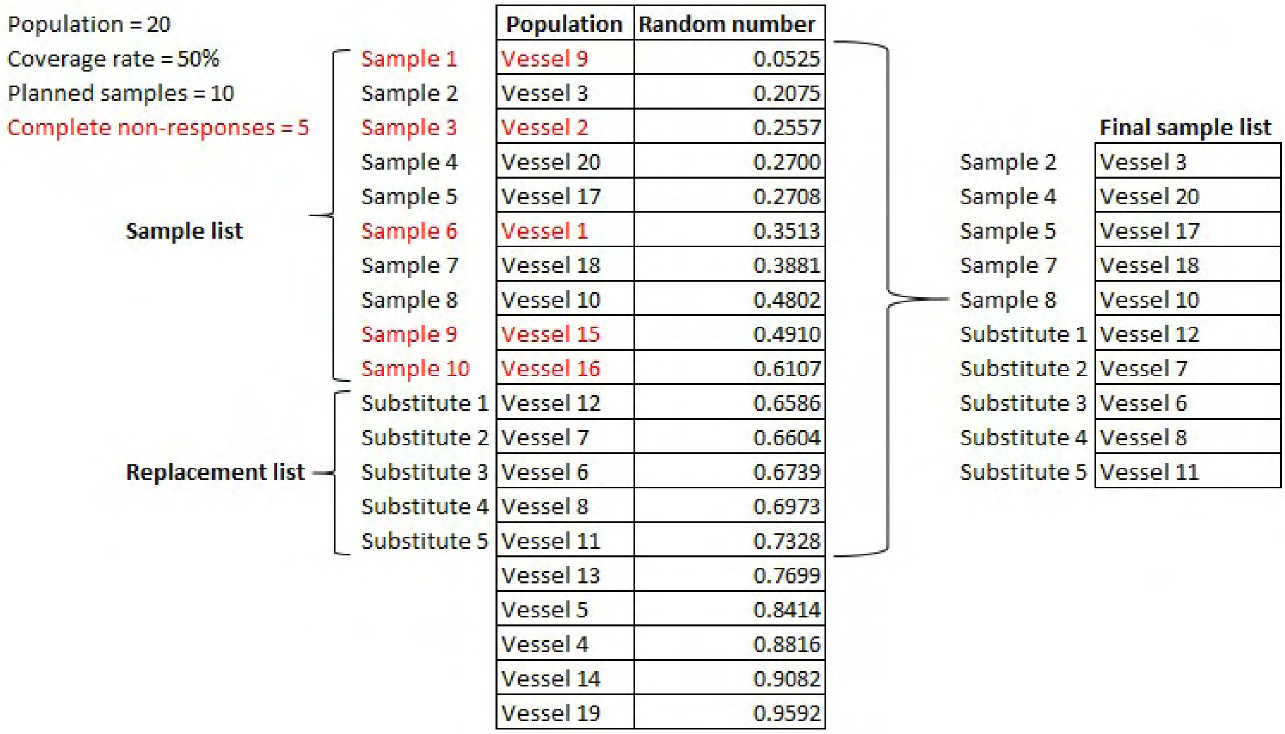

Figure 10. Replacement procedure for correcting CNRs when required

3.4.2 Data editing

Upon collection data have to be assessed in their quality (Sabatella and Franquesa, 2003). Data editing is a process in which data are checked and altered or corrected, as necessary, to ensure they are as error-free as possible. Data editing is not a stand-alone component, but rather it is an integral part of the data collection cycle. In particular, a number of non-sampling errors which result from data entry, data processing and/or interviewer errors can be eliminated or reduced through this process. It is implemented by applying a set of rules or range parameters for the variables which must be met if the data are to be considered validated (Pinello et al., 2017). The acceptable values for a variable, or a range of values can be set; even for the case where there are acceptable relationships between two or more variables, for example an acceptable range for the ratio between two variables (Pfeffermann and Rao, 2009). If these range parameters or rules are not met then corrective action may be, but is not always, taken. These rules are only intended as a tool to identify anomalies, however the final decision on whether or not a variable is accepted has to be made through human intervention and this approach is sometimes referred to as selective editing (Granquist and Kovar, 1997; Pfeffermann and Rao, 2009).

A further set of conditions often motivate closer, more systematic data editing of the sample data (Pinello et al., 2017):

- When a survey programme is in the early stages and structured time-series data are not available it is difficult to assess the soundness of the final estimates in a precise manner.
- Under the premise of capacity development for the survey team the careful examination of the sample data allows for an examination of the work done at the sample level by each data collector and the identification of areas for improvement. Further, in some cases the payment of the data collectors may be directly linked to the quality of their work and this has to be assessed carefully.
- Administrative requirements that require this level of detailed editing, such as statistical standards that are set at the national level.
- The sample data may be part of the output required by the public administration or ministry and this raw data may also be necessary to conduct a detailed analysis

Aside from the motivations discussed in the prior section, the degree of care taken to identify errors is set by the goals of the collection and it is often not necessary to identify every error. If the final estimate is coherent with the expected results then it may be acceptable to ignore errors at the sample level because they have not impacted on the overall validity of the final estimates (Pinello et al., 2017). Some surveys specify that respondents should be re-contacted if the number of edit failures is large or if key survey items are flagged as erroneous or questionable (Pfeffermann and Rao, 2009). Thus, missing, inconsistent, and questionable data can be eliminated through a re-confirmation of the respondent's input. In case re-contacting respondents is not possible, then the values may be inserted or corrected through the imputation process, that applies by means of deducing the correct value based on other information on the questionnaire or from what is known about the sample unit from prior surveys (Pfeffermann and Rao, 2009).

3.5 Statistical Inference

3.5.1 Estimation of the population parameters

The central tendency is the extent to which all the data group around a central value (Levine *et al*., 2008) and this is mainly measured through the mean. The dispersion of the values is described through the variance and standard deviation (Cochran, 1977; Sapsford and Jupp, 2006), while the relative frequency of occurrence of a value is measured through the probability. It can be represented by the area under a curve – also called the frequency distribution (Figure 11) (Sapsford and Jupp, 2006).

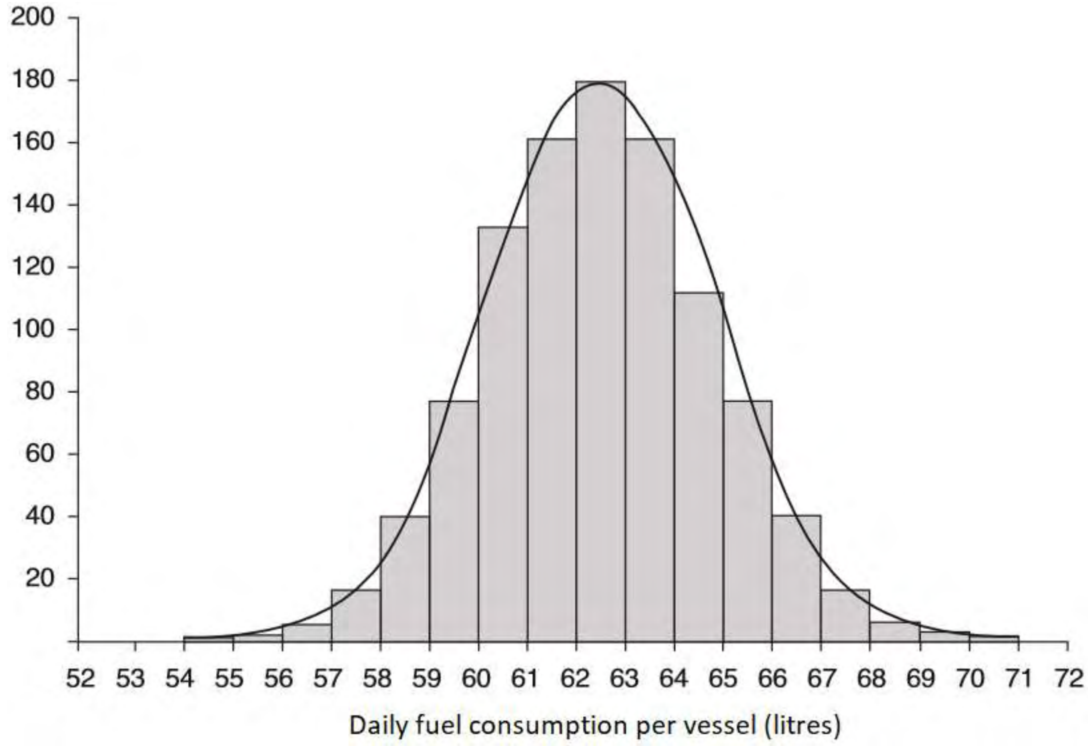

Figure 11. Hypothetical distribution of daily fuel consumption in a sample of 1000 vessels

3.5.2 Means, variance and standard deviation

The mean is the arithmetical average and it is calculated by simply summing the total daily fuel consumption of all vessels and dividing this by the number of vessels. The mean is at the centre of the distribution where half of the vessels are above the mean and half are below it. The standard deviation of a population is found by calculating the mean; finding the difference between each value and the mean; squaring each of the differences (deviations) so obtained; adding them all up; dividing by the number of values averaged; and finding the square root of the final answer to get back to the original scale of measurement. The histogram in Figure 11 provides a graphic presentation of an example of the frequency of occurrence of daily fuel consumption rates for a sample of 1 000 fishing vessels. The continuous curve showed in the same figure is another way of representing the same information and the histogram makes it clear that what is represented by the area within the figure, or under the curve, is the frequency of occurrence.

The same example provided in Figure 11 is an ideal example with the curve following a normal distribution and is perfectly described by its mean and standard deviation. Once the mean and standard deviation of any normally distributed variable are known the distribution and shape of the distribution can be well approximated. Thus, if one had the daily fuel consumption of just one vessel there would be a nearly 100 % probability that it would fall somewhere under the curve shown. There would be a high probability that its actual value would be somewhere between 1 standard deviation above and 1 standard deviation below the mean, since 68 per cent of the area of the curve in any normal distribution is in this range. There would be a low probability of it being greater than 2 standard deviation above the mean, because less than 2.5 per cent of the area under the curve is that far above the mean.

Moving iteratively, deviation can be first calculated, and this then followed by the calculation of standard deviation. Deviation scores can be both positive and negative, with the mean acting as the zero value and so, if you summed them, they would add to zero. Negative values give performance below the mean (in this case liters of fuel) while positive values are above the mean. The standard deviation is calculated by dividing each deviation score by the standard deviation and so standard deviation values are unitless. The z-score is calculated by dividing the difference between the value and the mean and diving by the standard deviation (Levine et al., 2008). A z-score of +1.96 is 1.96 standard deviations units above the mean. A z-score of −1.96 is 1.96 standard deviation units below the mean. For any normal distribution, these values mark off the lower and upper 2.5 per cent of the area under the curve. Thus, a value which is outside the range of ± 1.96 standard deviations from the mean has a probability of occurring less than five times in every 100 trials. This is usually written as $P < 0.05$. Although the example is raised using an individual data item, the work in the dissertation utilizes the mean values to provide a representation of how accurate the estimates of population parameters are.

3.5.3 Raising samples to the population

The counterpart to sampling is estimation: once a survey has been designed; the data collectors selected and trained; the correct questionnaires devised, and data collect and, finally, the data and checked with their quality assessed, (summarizing here all the main phases described up to this point) the final estimates can be produced (Snijkers et al., 2013).

As it is clear from the previous discussion, the data can be modified extensively during data processing. Hence, data processing has the potential to improve data quality for some variables while increasing the error for others (Pfeffermann and Rao, 2009).

The fundamental step in estimation is the accounting for the differential sampling incorporated into the sample design and this is done by multiplying each observation by a weight to form an estimate. The starting point is to use the inverse of the probability that a unit was included in the sample as its weight. So, if the probability that a unit i would be selected in the sample (measured over repeated sampling) is π_i, then the weight given to that unit in estimation when it has been selected is p_i=1/ π_i. This is known as Horvitz–Thompson (HT) estimation (Horvitz and Thompson, 1953), and estimates of the form:

$$\hat{Y} = \sum_{i=1}^{n} y_i p_i = \sum_{i=1}^{n} y_i \frac{N}{n} = \sum_{i=1}^{n} N \frac{y_i}{n} = N \sum_{i=1}^{n} \frac{y_i}{n} = N\bar{y} \qquad (3.6)$$

Where $\hat{Y}$ is the parameter to be estimated,

N is the population of the stratum,

n is the sampled population of the stratum

p_i is the weighting factor of the sample,

$\bar{y}$ is the mean of the parameter of the stratum

The estimate of the parameter will be unbiased if the design is measurable, which means that $p_i > 0$ for all *i.* When simple random sampling without replacement has been applied and all of the samples have the same probability of being selected, p_i = N/n. The Horvitz–Thompson estimation is straightforward because it only uses information on the selection probabilities from the sampling design and does not account for any other information. Using an HT estimation with probability proportional to size (PPS) sampling does requires information on the auxiliary variables, previously applied at the sampling stage (Sabatella and Franquesa, 2003). However, the weighting approaches related to the use of the HT estimator are not considered in this dissertation.

Capital costs

Capital costs (depreciation and opportunity costs) are intangible costs, without an implied outflow of cash.

Depreciation costs

To calculate depreciation costs, you should apply a mixed strategy where data from the survey are used to feed the perpetual inventory method (PIM). This method is recommended by OECD as well as by various national statistical offices. The PIM model calculates the values of the physical capital by aggregating the active fleet by age classes in the current year.

The model is based on some assumptions and requires the input of the following parameters:

a) price/capacity unit
b) depreciation rates
c) share of capital components in total value

d) asset lifespan

e) yield of long-term government bond.

The price/capacity unit (a) has a disproportionately large impact on the results of the model. It can be estimated through various sources, such as:

- new vessel construction prices second-hand price
- insurance values for the current yearbook values
- scrapping values
- ad hoc surveys.

Parameters b), c) and d) all have assumptions based on IREPA (2006). The depreciation function utilised assumes that renovations are conducted on the following schedule:

- Engine – 10 years
- Electronics – 5 years
- Other equipment – 7 years.

While the share of the capital components in total value are:

- Hull – 60%
- Engine – 20%
- Electronics – 10%
- Other equipment – 10%.

Opportunity costs

The implicit cost incurred when an alternative action is forgone but a payment is not made. Opportunity costs can be calculated using the PIM, as outlined above, or they may be calculated as the fixed tangible asset value multiplied by the real interest.

$$r = [(1 + i) / (1 + \pi)] - 1 \quad (3.7)$$

Where r is the real interest,

i is the nominal interest rate of the year concerned

π is the inflation rate in the year concerned.

3.6 Overall conclusion

In the course of this section 'Data collection and structure', both the theory behind survey sampling as well as the practical application of surveys and the subsequent application of empirical tools were discussed. The focus was placed on the surveys to be used; the types of data to be collected in sample surveys; how to conduct the survey, collect, check and process the data; and finally calculate the indicators. The full set of variables were presented, disaggregated to the level of micro-variables, with a detailed definition and clear description of the use of each variable in the course of the analysis. The full presentation of the definitions was important to fix the consistency of the definition as this is particularly important for conducting analyses at the regional and global level.

B) Analysis

3.7 Indicators and reference points

Indicators are defined as a variables, pointers or indices related to a criterion. The fluctuation in the performance of the indicator reveals variations of critical elements of either fishery resources – or – more specifically – the social and economic well-being of the fishery sector

(FAO, 1999). The relative performance and the trend in performance present a picture of the current performance as well as a time-series of the performance. The indicators used here are both composites of variables as well as single variables where performance was measured against reference points and also between fleet segments. The indicators are shown grouped by the relevant variable categories.

Variable category: Engagement

Indicator: Ownership

Engagement of owner on the vessel and ownership structure. The distinction between levels of engagement is important as it has been found in some studies that the profitability of vessels with the owner engaged on-board the vessel was higher than those without owner-engagement.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

As a rule of thumb, the smaller the vessel the more likely it is that the owner is engaged on board.

Indicator: Engaged crew (on board)

The engaged crew is defined as the number of jobs on board and this includes both temporary and rotational crew.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Total number of individuals on the vessel

The number of different individuals working for the vessel: all people ever engaged in the reference period. For example, if there are two crew positions there may be three different people who, at some point, work in those crew positions.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years, or against similar fleet segments, to give an indication of performance.

Indicator: Average working hours per crew member

The average working hours accounting for all of the individuals ever engaged during the reference period.

Methodology for the calculation

[(Number of vessels per segment from the fleet register) × (average number of days at sea) × (average number of crew per vessel) × (average number of hours of work per crew member per day at sea)] / [(number of vessels per segment from the fleet register) × (average number of individuals)]

Performance benchmark

National or ILO Convention C180 (2 000 hours). Note that exceeding the benchmark limit is not an indication of positive performance.

Indicator: Working hours

This refers to any time on board the vessel that the crew is required to do work on account of the vessel, including fishing activity, but also any other activities like cleaning, repair and maintenance.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years, or against similar fleet segments to give an indication of performance.

Indicator: Total engaged crew

The total number of crew engaged across the whole fleet.

Methodology for the calculation

(Number of vessels per segment from the fleet register) × (average number of individuals)

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years, or against similar fleet segments to give an indication of performance.

<u>Indicator: Engaged crew (FTE national) (on board)</u>

Full-time equivalent (FTE) national is based on the national reference level for FTE working hours of the crew members on board the vessel and the working hours onshore. The FTE equals the ratio between the hours worked and the reference level. In some exceptional cases, a cap at the threshold value was applied where any working hours per crew member in excess of the reference level are corrected downward to 1 FTE.

Methodology for the calculation

[(Number of vessels per segment from the fleet register) × (average number of days at sea) × (average number of crew per vessel) × (average number of hours of work per crew member per day at sea)] / (threshold*)

* The threshold is defined according to the features of the fishery sector in the country. For example, it can be the same value used in a similar sector (e.g. agriculture) or it can be the national definition of a full-time worker (e.g. 1 760 = 8h/day * 20 days/month * 11 months).

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

<u>Indicator: Engaged crew (FTE harmonized)</u>

Full-time equivalent (FTE) harmonized is based on a threshold of 2 000 hours per FTE.

Methodology for the calculation

[(Number of vessels per segment from the fleet register) × (average number of days at sea) × (average number of crew per vessel) × (average number of hours of work per crew member per day at sea)] / (threshold*)

* The threshold is set at 2 000 hours per year, because that is an international threshold commonly used in the agricultural sector and therefore can be considered as the standard unit of measurement for a full time working position.

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years, or against similar fleet segments, to give an indication of performance.

Variable category: Activity

Indicator: Days at sea

The standardized fishing time spent actively fishing.

Methodology for the calculation

Single variable indicator – *directly obtained from variable* Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Duration of fishing trip

Any continuous period of 24 hours (or part thereof) during which a vessel is at sea during the interview period with a minimum reporting of one day.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Volume of landings (kg)

The total volume of catch landed.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Self-consumption

Quantity of landings per trip not sold but used by the fishers for their own consumption or their families' consumption, including sharing of catch for crew remuneration.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Variable category: Variable costs

<u>Indicator: Personnel costs</u>

Remuneration paid to the crew[3].

Methodology for the calculation

Single variable indicator – *directly obtained from variable* when a fixed salary is paid. When share system is utilized the variable was calculated based on this actual formula used.

Performance benchmark

When present, the minimum wage for the sector, a comparable sector or the national minimum legal wage can be used as a benchmark value. Moreover, the trend can be assessed against previous years or against similar fleet segments to give an indication of performance.

<u>Indicator: Energy costs</u>

Cost of consumed fuel and lubricants for the vessel.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

[3] Note on unpaid labour: In the cases where the owner(s) made up the only crew for a vessel then the remuneration and profit were, in practical terms, merged. Although the calculation was for a figurative value it is still important to calculate so that there was no "unpaid" or unaccounted remuneration and the personnel costs include everyone on the vessel.

Indicator: Energy consumption

Type and volume consumed (in litres) for fuel and lubricants used on the vessel.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Other operational costs

All the purchased consumable inputs related directly or indirectly to fishing effort that are not related to maintenance and are consumed within the given year.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Commercial costs

All the costs related to selling the production resulting from the activity of the vessel.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Repair and maintenance costs

The costs for maintenance and repair to the vessel and gears which included both routine and extraordinary maintenance/repairs.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Indicator: Fixed costs

The costs not directly connected with operational activities (effort and catch/landings). Fixed costs do not change in relation to the level of activity of the vessel (they remain the same whether there is one trip per year or 200 trips per year).

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Variable category: Investments

Indicator: Investments

The value of the vessels at the end of the previous calendar year, plus any improvements to existing vessel/gear during the survey period.

Methodology for the calculation

The value of the vessel is calculated through the PIM model while the improvements are calculated as a single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years or against similar fleet segments to give an indication of performance.

Variable category: Economic

Indicator: Revenues

Value of production measured as the sale of landed fishery products and income generated from the use of the vessel in other, non-commercial fishing activities.

Methodology for the calculation

Income from landings plus other income

Performance benchmark

Benchmarked against other fleet segments and/or years.

Indicator: Gross cash flow (GCF)

GCF was used to represent the total amount of cash that the business generated each year. Typically, it has been considered as one of the main indicators for the feasibility of the survival of fishing companies or establishments in the short term. When calculated as a percentage of revenue, it indicated the normal profitability of the operations and was of particular of most interest to fishers because it represents the share of income they are left with at the end of the year. A high ratio indicated that the sector had a low-cost operating model and reflected an efficient conversion of inputs into outputs, while a low ratio indicated a low margin of security where there was a higher risk that any decline in production, or increases in costs, could have resulted in a net loss.

Methodology for the calculation

Revenues – (energy costs + personnel costs + repair and maintenance costs + other operational costs + commercial costs + fixed costs)

Performance benchmark

It can be calculated both in absolute terms and as a percentage of revenue. And, once data from previous years are available, you can assess the trend against previous years using three performance classes (measured as the short-term performance (Step)):

Table 12. Descriptive performance trends based on Stp values

Change (year *i*)/ (year *i − 1*: *y − 2*)	Status
Stp >= 105%	Improved
95% <= Stp < 105%	Stable
Stp <= 95%	Deterioration

Indicator: Gross value added (GVA)

GVA is the net output of a sector after deducting intermediate inputs from all outputs and it is a measure of the contribution to GDP made by an individual producer, industry or sector. It also shows the percentage of revenues directed to remuneration, profit, opportunity cost and depreciation.

Methodology for the calculation

Revenues – (energy + repair and maintenance cost + other operational costs + commercial costs + fixed costs)

Performance benchmark

It can be calculated both in absolute terms and as a percentage of revenue. And, once data from previous years are available, you can assess the trend against previous years using three performance classes (measured as the short-term performance (Stp)):

Table 13. Descriptive performance trends based on Stp values

Change (year i)/ (year $i-1$: $y-2$)	Status
Stp >= 105%	Improved
95% <= Stp < 105%	Stable
Stp <= 95%	Deterioration

Indicator: Capital productivity (return on fixed tangible assets, ROFTA, %)

Measurement of the profits in relation to capital invested that was defined as a percentage of the return of the investment divided by the cost of the investment.

Methodology for the calculation

[(economic profit + opportunity cost of capital)/tangible asset value)] × 100

Performance benchmark

The higher the return, the more efficient the sector is in utilizing its asset base.

Indicator: Economic profit

The difference between outputs or revenue and total (explicit) costs of inputs. Explicit costs include all operational costs, such as wages, energy, repair, depreciation and opportunity costs of capital. This indicator was the primary indicator of economic performance and is often used as a proxy of resource rent in fisheries. It provides an indication of the sector's operating efficiency and, if expressed as a percentage of revenue, it captures the amount of surplus generated per unit of production. Economic profit differs from gross profit in that it includes depreciation and the opportunity costs of capital.

Methodology for the calculation

Economic profit = revenue – (operating costs + annual depreciation + opportunity costs of capital).

Performance benchmark

It can be calculated both in absolute terms and as a percentage of revenue (i.e. economic profit margin). It can also be compared to other fleet segments, other similar sectors and, of course, against the performance of other years. When calculated as a percentage of revenue the performance can be classified as high, reasonable, or weak as demonstrated by Table 14 (STECF, 2015):

Table 14. Descriptive performance based on the economic profit as a percentage of revenue

Economic profit /revenue	Status	Description
>10%	High	Profitability is good, and segment is generating a good amount of resource rent

0-10%	Reasonable	Segment is profitable; generating some resource rent
<0%	Weak	Segment is making losses; economic overcapacity

Indicator: Break-even revenues

Break-even revenues represent the point at which costs and revenues are equal.

Methodology for the calculation

(Fixed costs + opportunity costs of capital + depreciation)/ [1− (personnel costs + energy costs + repair and maintenance costs + other variable costs)/revenue]

Indicator: Short-term performance (STP) (European Commission, 2005)

This indicator was calculated after the third year of data collection, although it also be could be calculated after the second year. It includes GCF as a short-term indicator in fisheries and points out the feasibility of survival of a fishing company. STP makes a good short-term indicator in fisheries as positive GCF means that the company is capable of paying for all its operational costs and meeting at least part of its obligations to its creditors.

Methodology for the calculation

(GCF in Year i)/ (average GCF of (year $i-1$: y − 2))

Performance benchmark

Three performance classes are distinguished:

Table 15. Descriptive performance based on the short-term performance of the GCF

Change (year i)/ (year $i-1$: $y-2$)	Status	Description
>10%	High	Profitability is good, and the segment is generating a good amount of resource rent
0-10%	Reasonable	Segment is profitable; generating some resource rent

<0%	Weak	Segment is making losses; economic overcapacity

Indicator: Medium-term indicator (MTI) (European Commission, 2005)

For the medium-term performance, the average realised revenues for the period (year i: y i − 2) are compared to the required break-even revenue. The break-even revenue represents a level of production at which all costs are covered, so that the segment could implement regular replacement investments in the long run and, generally, economic results performing at a break-even level usually imply very satisfactory profitability in fiscal terms.

Methodology for the calculation

(average revenue in Year i)/ (break-even revenue (year $i - 1$: y − 2))

Performance benchmark

Four performance classes are distinguished in Table 16:

Table 16. Descriptive performance based on the medium-term performance

(average revenue in Year i)/ (break-even revenue (year $i - 1$: y − 2))	Status	Description
mti >= 105%	Strong	Vessels have no problems meeting all their financial obligations
95% <= mti < 105%	Reasonable	All costs are mostly covered, at low level of profits or losses
85% <= mti < 95%	Weak	Minor losses lead to deterioration of solvability
mti <= 85%	Very Weak	Losses, probably also in fiscal terms, have been incurred in previous years

Indicator: Depreciation costs

The reduction in the value of the capital invested with the passage of time, due in particular to wear and tear.

Methodology for the calculation

Calculated through the PIM model, where The PIM model calculates the values of the physical capital by aggregating the active fleet by age classes in the current year.

Performance benchmark

The benchmark of costs is not made by considering absolute values but is measured relative to the other costs of the vessel and against the revenues. This relative value can then be benchmarked against the performance of other years.

<u>*Indicator: Opportunity costs*</u>

The implicit cost incurred when an alternative action is forgone but a payment is not made.

Methodology for the calculation

Calculated through the PIM model, where The PIM model calculates the values of the physical capital by aggregating the active fleet by age classes in the current year.

Performance benchmark

The benchmark of costs is not made by considering absolute values but is measured relative to the other costs of the vessel and against the revenues. This relative value can then be benchmarked against the performance of other years.

<u>*Indicator: Debts*</u>

The percentage of assets covered by loan.

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

It can be measured relative to other fleet segments or years.

Indicator: Subsidies to GVA (%)

Subsidies are monetary payments received from the government that can be in the form of money or monetary reimbursements for purchases that modify the potential profits by the industry in the short, medium or long term. For this indicator, subsidies were measured as a percentage of the GVA and it provides a measure of the reliance on subsidies within the sector.

Methodology for the calculation

(GVA/revenues) × 100

Performance benchmark

It can be measured relative to other fleet segments or years.

Variable category: Socio-economic

Indicator: Remuneration per FTE

Remuneration provides the main measure of the contribution to livelihoods for the fishers and, being often paid by crew shares proportional to the income, it is also proportional to the overall economic performance.

Methodology for the calculation

Personnel costs*/FTE *includes unpaid labour and excludes taxes

Performance benchmark

It is measured in absolute terms and relative to a minimum wage. The minimum wage can be set nationally or within the same or similar sectors (average or legal wage).

Indicator: Labour productivity (monetary value/FTE)

Labor productivity (LP). The measure of productivity for fisheries used here was the ratio of the output per unit of labor, measured as full-time equivalent employment (FTE). LP is a measure of productivity taken from the ratio of the output per unit of (input) FTE labor. The underlying theory posits that LP is a reflection of the technology utilized for the fishing activity combined with the motivation and skills of the fishers involved (OECD 2008). Typically, within economic theories, increases in LP have been viewed as positive outcomes. Increases in LP performance could result from either an increase in the output of revenues less costs (numerator) relative to the denominator, or by decreasing the denominator (labor) relative to the numerator. Remuneration is compared to the minimum wage and used as a proxy for the contribution to livelihoods.

The Gross value added (GVA) values were adjusted for purchasing power parity (PPP). LP was calculated as: GVA/FTE. The FTE calculation incorporated the hours worked as well as the number of persons employed (head count). The productivity calculated in this way captures the use of the labor input better than productivity calculated only based on the number of persons employed (OECD 2016). GVA/vessel (PPP) was used to represent the net output of fisheries after deducting intermediate inputs from all outputs, in this case reported per vessel. GVA represented the portion of revenues directed to remuneration, profit, opportunity cost and depreciation. GVA/vessel was measured as: revenues − (energy costs + repair + maintenance costs + other operational costs + commercial costs + fixed costs).

It is a measure of productivity as a result of labour inputs that takes into account both the hours worked and the people involved. The indicator is: output per unit of labour, calculated as GVA (measure of output) by full-time equivalent (FTE) employment (unit of labour input). Expressed in monetary value per full-time equivalent, nominal value.

Methodology for the calculation

GVA/FTE

Performance benchmark

It can be calculated both in absolute terms and as a percentage of revenue. And, once data from previous years are available, you can assess the trend against previous years using three performance classes:

Table 17. Descriptive performance trends based on GVA/FTE values

Change (year *i*)/ (year *i − 1*: *y − 2*)	Status
Stp >= 105%	Improved
95% <= Stp < 105%	Stable
Stp <= 95%	Deterioration

Variable category: Demographics

<u>*Indicator: Age of crew members*</u>

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

It can be assessed against the average age of the population or against similar sectors (e.g. agriculture). It is also meaningful to assess the trend over the years.

Indicator: Literacy level of crew members

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

It can be assessed against the minimum legal literacy level of the country or against the average literacy rate of the population or against similar sectors (e.g. agriculture). It is also meaningful to assess the trend over the years.

Indicator: Nationality of crew members

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

It can be assessed against similar sectors (e.g. agriculture). It is also meaningful to assess the trend over the years.

Indicator: Number of household members engaged in fishing

It provides an indication of the total number of people who rely on the sector

Methodology for the calculation

Single variable indicator – *directly obtained from variable*

Performance benchmark

Because it is difficult to assign an independent benchmark value, it is best to assess the trend against previous years, or against similar fleet segments to give an indication of performance.

Variable category: Technical indicators

Indicator: Capacity utilization (CU)

The ratio of actual to potential output. The most accurate calculation is made through econometric methods, for example with data-envelopment analysis. The more practical (but less accurate) calculation is calculated here as actual sea days to potential sea days. It represents the degree to which the vessel is fully utilized. From an input- based perspective, this may relate to the ratio of the sea days to the number of days the boat could potentially be at sea under normal working conditions (Ward et al., 2004).

Methodology for the calculation

Days at sea/maximum days at sea[4]

Performance benchmark

It can be measured relative to other fleet segments or years.

Indicator: Inactivity level (IL)

[4] based on the average activity of the top 10 % of the most active vessels in that particular fleet segment.

The proportion of the total fleet population that is inactive (i.e. with no fishing activity during the survey period).

Methodology for the calculation

Number of inactive vessels in fleet/total fleet

Performance benchmark

It can be measured relative to other fleet segments or years.

Variable category: Environmental indicator

<u>*Indicator: Fuel efficiency of seafood landing*</u>

Landing per tonne of fuel consumed. It is an environmental indicator that measures the efficiency of harvesting in terms of fuel consumption.

Methodology for the calculation

Landings (tonnes)/fuel consumption (tonnes)

Performance benchmark

It can be assessed against other fleet segments or years or in cross-sectoral comparisons relative to the average age of the population or against similar sectors (e.g. agriculture). It is also meaningful to assess the trend over the years.

3.7.1. Selected Indicators

The indicators this dissertation focus on were pulled as a subset from the broader subset of socio-economic indicators which were described in detail in section 3.7 (Bonzon 2000; Franquesa et al., 2001; Accadia and Spagnolo 2006). The selection of the indicators was made based on partially on expert opinion, but most strongly based on data availability due to the use of these indicators in the Common Fisheries Policy of the EU (EU 2016) and in the EastMed project (Pinello and Dimech 2016). The indicators were grouped into three categories: labour-related; performance and macroeconomic indicators. The indicators were all sourced from *A sub-regional analysis of the socio-economic situation of the Eastern Mediterranean fisheries*, referred to above (Pinello and Dimech 2016), with the exception of labour productivity which was sourced from the *Handbook for fisheries socio-economic sample survey—principles and practice* (Pinello et al., 2017; STECF 2013).

Labour-related indicators

Table 18 provides a summary table of the indicators selected, their definitions and the relevant units and acronyms.

Table 18. Indicator acronyms, units and definitions

Indicator	Abbreviation	Units	Definition
Employment	FTE		Employment in full-time equivalent (FTE)
Remuneration per fisher	-	USD/ FTE	Remuneration values including unpaid labour
Remuneration per fisher/minimum wage	REM	-	Average remuneration per fisher compared to sectoral minimum wage for the country
Gross Value Added	GVA	USD	The net output of fisheries after deducting intermediate inputs from all outputs. GVA shows the portion of revenues directed to remuneration, profit, opportunity cost and depreciation
Labour productivity	LP	-	Measure of productivity for fisheries calculated as ratio of the GVA (output) per FTE
Minimum wage (PPP)	-	USD	Minimum wage of national manufacturing sector
Gross domestic product per capita (PPP)	GDP	USD	Expenditure on final goods and services minus imports: final consumption expenditures, gross capital formation and exports less imports

3.8 Overall Conclusions

After the variables were defined in the first section of this chapter, the indicators were calculated. Reference points were introduced to benchmark the performance of the indicator to reveal fluctuations in performance for the elements of interest. Amongst the indicators, labour productivity, as a measure of productivity for fisheries used here was the ratio of the output per unit of labor.

CHAPTER 4: RESULTS AND DISCUSSION

4.0. Introduction

In this chapter remuneration under the crew-share system and labour-related indicators were examined in two sections. In the first section, remuneration, the most important socio-economic characteristic of a fishery, was examined and proposed as an indicator of socio-economic performance and contribution to livelihoods. In the second section, the indicator labour productivity was investigated along with the elements used to calculate it. These were all detailed along with the role of factors internal and external to fisheries. The results of both section were discussed in the context of the implications for good quality socio-economic data for fisheries management.

Four countries, Egypt, Lebanon, Italy and Greece, were selected based on their inclusion in the FAO EastMed project and in the associated technical document (Pinello and Dimech, 2016) and the resultant availability of data. Further, the countries were selected as the author was directly involved in the respective data collection programmes. The data included here was collected through the use of compatible methodologies and, as a result, exhibited a high degree of consistency and comparability. The fact that the fishing fleets of the four countries all operated in the semi-enclosed Mediterranean Sea—and in some cases shared the same stocks—provided an opportunity to draw meaningful comparisons between them, while their diverse socio-economic conditions added depth and richness to the study.

Labour was the main cost component in the four countries analysed, Egypt, Lebanon, Italy and Greece (Pinello and Dimech, 2016), but it also forms the basis of another indicator, namely the efficiency of labour, measured as labour productivity. In a general sense, productivity is used to measure the ratio of outputs relative to the required inputs. Changes in efficiency and further, changes in economic performance of this sector can be demonstrated through changes in this ratio. In most fisheries economic analyses, productivity is used as an indicator of economic performance and the viability of the sector, and this is also the case for fisheries (OECD, 2008; Walden et al., 2015).

Labour productivity has been applied as one measure of the well-being or standard of living of fishers, with the assumption that increases in productivity are matched by wage increases (STECF 2016). The disconnect between productivity and remuneration has been well described in the global and national contexts (Fleck et al., 2011; Mishel, 2012; Schwellnus et al., 2017) and in sector-specific literature, such as for agriculture (McCullough, 2017), from which parallels to the fisheries context are readily drawn (Urquhart and Alcott, 2013). However, this decoupling has been little explored in the fisheries literature, aside from a few exceptional cases (Urquhart and Alcott, 2013; Gallizioli, 2014). In this thesis, an examination has been made of the interaction between the elements used to calculate labor productivity in a bid to analyze whether labor productivity, as an indicator adequately captures the contribution made by fishing to the livelihoods of fishers.

4.1 A novel sampling methodology for estimating salaries

Labour cost, or remuneration, was found to often be the main component of costs in fisheries around the world. Their proportion of total costs usually vary from 30 to 50 % of the total costs (World Bank and FAO, 2008). A main factor on the relative percentage of labour costs has often been found to be fuel costs which are of course variable and most often tracked the cost of oil. For example, for the fishing fleet of the European Union (EU), labour costs were estimated to be 36 % of total costs in 2012 (STECF, 2014) and they accounted for 39 % of the total operating costs of the fleet in the eastern Mediterranean in the same year (FAO EastMed, 2016). In Italy in 2012, the average labour cost was 33 % of total costs (STECF, 2014). In small-scale fleets, labour costs are even higher. For example, the small-scale fleet in the eastern Mediterranean recorded labour costs of 47 % of total costs in 2012 (FAO EastMed, 2016).

4.1.1 The extent of crew-share remuneration systems

"*I was already aware that in the whaling business they paid no wages; but all hands, including the captain, received certain shares of the profits called lays…" Moby Dick* (Melville, 1851).

The crew-share system is, and has been throughout history, the most common way remuneration has been paid. In the crew-share system the crew receives a proportion of the gross returns (Zoeteweij, 1957; Griffin et al., 1979; Guillen et al., 2017; OECD, 2013). The proportion of the crew-share payments may be calculated based only on the gross returns, or it may be made as a "top up" above a fixed amount of above the minimum wage (Guillen et al., 2017). Reference to a crew-share scheme is made in Moby Dick, written by Herman Melville in 1851. Further, a study conducted by the International Labour Organization nearly 80 years ago (Sutinen, 1979) found that the share system was the dominant method of payment in fisheries in the countries they studied around the world. The use of crew-shares was described in detail along the Adriatic coast of Italy in the late 19th Century (Salvemini, 1897) and again in the 1950s (Salvemini, 1955).

4.1.2 Theoretical motivation for crew-share based remuneration

The payment of labour in fisheries through the crew-share system, rather than through a fixed rate, is motivated by the fact that it allows for the sharing of risk between the vessel owner and the crew, and that it provides a clear incentive for fishing crews to perform as well as possible (Sutinen, 1979; Griffin et al., 1979; Stiglitz, 1974; Plourde and Smith, 1989). The crew-share system also enables the crew to capture part of the fisheries rent (Sutinen, 1979) and this enhances productivity (Weitzman and Kruse, 1990). Because the crew-share system provides incentives based on outputs in situations where monitoring of worker's effort may be unobservable or costly (McConnell and Price, 2006; Reynolds and Greboval, 1988) it solves the principal–agent problem (Vestergaard, 2010).

The "on-the-deck" conditions of fisheries work support the theories developed around the risk-and-rent-sharing motivations. The short period of time between input (effort) and output (landing) and the easily defined nature of the output, make it logical to justify payments based on production (Sutinen, 1979). Although the nature of the activity and its accounting are relatively simple, the activity levels and outputs are unpredictable (Sutinen, 1979; Georgianna and Shrader, 2005; Jentoft and Eide, 2011). Additionally, crew-share remuneration has become a traditional or culturally acceptable system, and this further explains its global prevalence (Georgianna and Shrader, 2005; EU, 2016b) - even in highly managed fisheries with stable and predictable catches (Matthiasson, 1997; McConnell and Price, 2006; Abott et al., 2010). The tradition is rooted in the community and this might explain why, in fisheries with non-local labour, there has been a shift away from the crew-share system.

In summary, the crew-share system is prevalent in fisheries because it i) allows for risk sharing; ii) enhances productivity by providing incentives; iii) solves the principal−agent problem by providing motivation when the owner cannot monitor the worker; iv) reflects the straightforward nature of the accounting and the on-the-deck conditions in which fisheries operate; and v) it is also a matter of tradition and culture.

4.1.3 Forms of crew-share remuneration

To facilitate an easier understanding the diversity of crew-share systems already noted, with their broad spatial and temporal extent, were distilled into two main forms, as shown in below, in Figure 12.

1a: $r * c = x$ (4.1)

1b: $(r - a) * c = x$ (4.2)

where *r* is the revenue, *c* is the crew-share percentage, *a* are the activity costs and *x* is the remuneration. The two main parent forms encompass a diversity of formulas that are applied in fisheries and they generally reflect the different cost structures of fisheries.

Generally, there are more shares than crew members to allow for different rates of pay according to position and responsibility (Zoeteweij, 1957: Grafton et al., 2006) and the exact division of the crew-share portions varies according to local customs. In this application the formulas only consider the total amount assigned for crew-share, not the distribution between the different members of the crew and, although these details are generally not well described in the literature (Guillen et al., 2017), they are very important as they allow for insight into the real contribution that fisheries make to the livelihoods of crew members working in different positions. Typically, the base unit of measure is set on the salary of the deckhand at one share, while the skipper takes 2-5 shares, and any on-shore crew receives half of a share. Somewhere between the deckhand and skipper are the positions of engineer, cook, head fisher, etc. depending on the size and fishing activity of the vessel. For example, if there are 5 crew members and 10 shares: 4 shares go to the skipper; 2 shares to the engineer; 1.5 shares to the cook; 1 share each to the two deckhands and 0.5 share goes to the on-shore crew who are responsible for setting the gear after fishing activity. These details are important for allowing further insights into the real contributions to livelihoods for different crew positions.

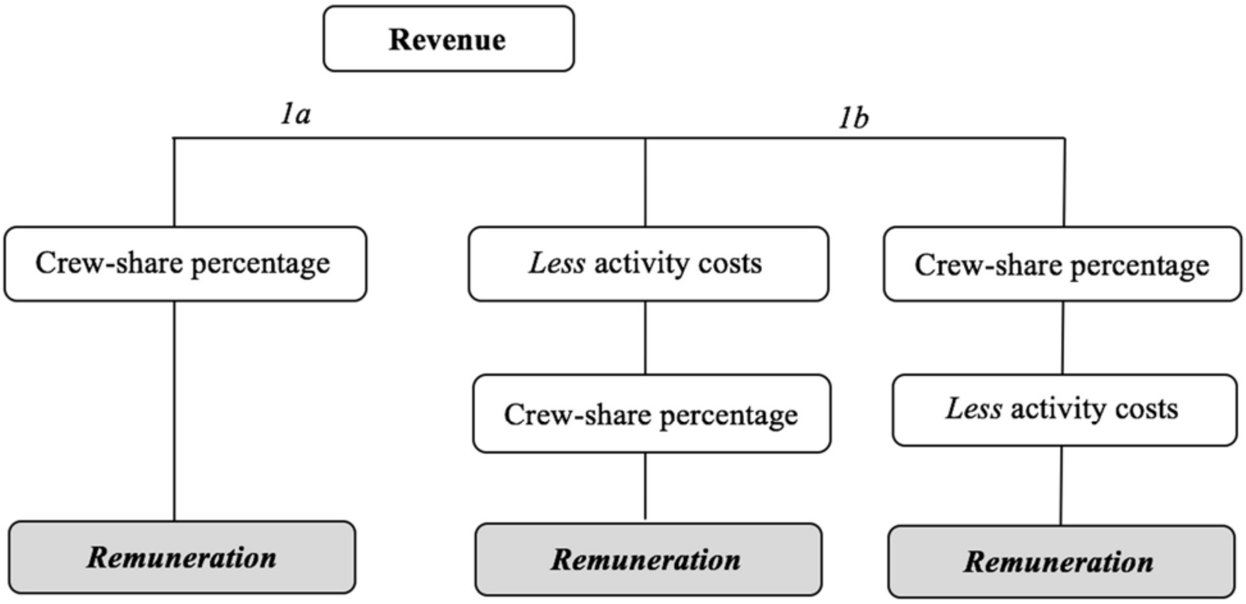

Figure 12. The two main forms of the range of crew-share formulas used**.**

The uncomplicated crew-share system 1a is likely to be the original form of crew-share, applied since ancient times. In this system, labour is paid as a share of the catch and it is this system that is to be found in references such as that of Melville (1851). In these crew-share systems − where crew remuneration is calculated as a straight percentage of the revenue − a logical starting point for dividing the remuneration revenue is to divide into thirds the labour component (crew); the capital component (vessel); and the cost component (Georgianna and Shrader, 2005). The straightforward nature of crew-share system 1a has contributed to its use in fisheries contexts that are equally straightforward. Use of this form of the crew-share system has been recorded from fisheries in the estuaries of Brazil (Kalikoski and Vasconcellos, 2012) to the sardine fisheries of Senegal (Deme, 2012), salmon fisheries of the Pacific Northwest and in small pelagic fisheries in the Philippines (Sotto et al., 2001).

The second class of the crew-share system, described as Option 1b make up the more complex forms of the crew-share systems. This category reflects the evolution of more complex fishing technology and it is has typically been applied in fisheries systems where operational costs are high relative to the revenue (FAO, 2000) around the globe (e.g. McConnell and Price, 2006; Abbott et al., 2010; Nguyen and Leung, 2009; Matthiasson, 1997; Beverly, Chapman and Sokimi, 2003; Uchida and Baba, 2008; Prellezoa and Iriondo, 2016; Guillen et al., 2017). Outside of situations where traditions or cultural issues do not play a strong role, option 1b is more convenient from the decision-maker's perspective. Once costs, as a percentage of revenue, reach a tipping point, as detailed in Table 19, then the owner should begin to subtract the daily costs from the revenue before applying the crew-shares. The costs can be deducted from the revenue either before or after the crew-share is calculated and this means that the crew-share is reduced by some portion of the costs. This therefore allows for the costs (and the risk) to be shared between the crew and the owner.

In Table 19, a hypothetical investigation was undertaken in order to determine the conditions in which it would be preferable to use Option 1b over Option 1a, from the owner's perspective. Option 1a was assigned a crew-share percentage of 33 % (one third) of the revenue, while for option 1b, 50 % of revenue was assigned to the crew-share system. These percentages represent a logical division of the risk and the remuneration of the activity and are have been identified in the literature globally (Kalikoski and Vasconcellos, 2012; Deme, 2012; Sotto et al., 2001). The proportions allocated in this extended exercise are applied with the acknowledgement that other proportions may be used. The point at which there is financial incentive for the owner to make the switch from the basic crew-share system 1a to 1b corresponds to these proportions.

Table 19. Relative advantage for the vessel owner under crew-share payment calculation scenarios

Daily	20% of	25% of	33% of	40% of	50% of

costs as:	revenue			revenue			revenue			revenue			revenue		
	1a	1b	*y**	1a	1b	*y**	1a	1b	*y**	1a	1b	*y**	1a	1b	*y**
Daily revenue	1000	1000		1000	1000		1000	1000		1000	1000		1000	1000	
Daily costs		200			250			333			400			500	
Crew share	333	400		333	375		333	333		330	300		330	250	
Owner share	**467**	**400**	**-67**	**417**	**375**	**-42**	**333**	**333**	**0**	**270**	**300**	**30**	**170**	**250**	**80**

Note: In this exercise, revenue is held constant while the proportion of costs to revenue varies. Option 1a: straight percentage of the revenue – the crew-share is 33 %. Option 1b: percentage of the revenue minus daily costs – the crew-share is 50 %. The switch point is found where the difference between option 1a and 1b is zero. *y** is the vessel owner's advantage or disadvantage (option 1b minus option 1a).

The exercise conducted in Table 19 showed that, for the owner, it is more fitting to use a simple crew-share (option 1a) when the costs are below 33 % of the revenue. However, once the costs reach or exceed 33 %, it is more favorable to discount the costs from the revenue (option 1b). Following the results of this exercise, the simple crew-share may have evolved into option 1b when fishing activities incurred production costs that were relatively high compared to revenue, with a confluence of increased fishing effort and increased use of technology on the boats (FAO, 2000). Today, there are still fishing areas and fishing systems where the switch point for costs has not been surpassed and the simple crew-share system remains in use (Kalikoski and Vasconcellos, 2012; Deme, 2012 and others, as above). This is typically the case for small-scale fisheries, fisheries targeting small pelagic fish and, in general, where the cost component is not a significant factor in relation to the revenue.

Interestingly, in some locations the crew-share system has an extended influence. For example, in cases where a flat rate remuneration system is place, the crew-share affects the wages paid under the flat-rate system (Allen and Gough, 2006). In these areas, crew-share system salaries appear to influence the salaries of a flat-rate wage system and this is likely the result of another matter of traditional fisheries culture: communication (Doeringer et al., 1986; Allen and Gough, 2006; EU, 2016b). Communication is a fundamental characteristic of the fishing sector. The need for communication is driven by the need for networks within harbours to share information about market prices; by the need for the community to support fishers while they are at sea; and the need for communication between fishers and their families (DG FISH, 2002). This communication ranges from discussions on the docks and in the auction market, to the widespread use of radio communication at sea. Besides having a social function, constant communication is underpinned by the need for maintaining a safe community and to share market information (DG FISH, 2002). A natural extension of this sharing of market prices and information about safety at sea is discussion about income and salaries. Therefore, even if both a crew-share and flat wage system are in use in one area, it is unlikely that the difference in pay would be substantial; apart from instances in which non-local labour is utilised (EU, 2016b), as the fishers would be unlikely to accept salaries lower than those of others. This phenomenon is observed in the European fisheries (EU, 2016b).

4.1.4 Results

The crew-share system makes the collection of data for socio-economic surveys more challenging because of the informal and unconventional nature of payments, and a general reluctance to report data. Grafton (2006) raised the complexity of the issue and proposed that labour costs may be estimated through the opportunity costs. However, it is proposed that the value for the amount of the crew remuneration is too difficult to acquire, in and of itself, and it is proposed that it is best captured using an indirect strategy. This strategy consists of the identification of the formula and the elements required for the calculation of crew remuneration. The formula elements are detailed below, and the process is focused on collecting these elements in a specific order: from the easiest to most challenging data to collect. The remuneration is estimated for all crew members – including owners who are engaged on board the vessel.

Collection of the elements to calculate remuneration based on the crew-share formula

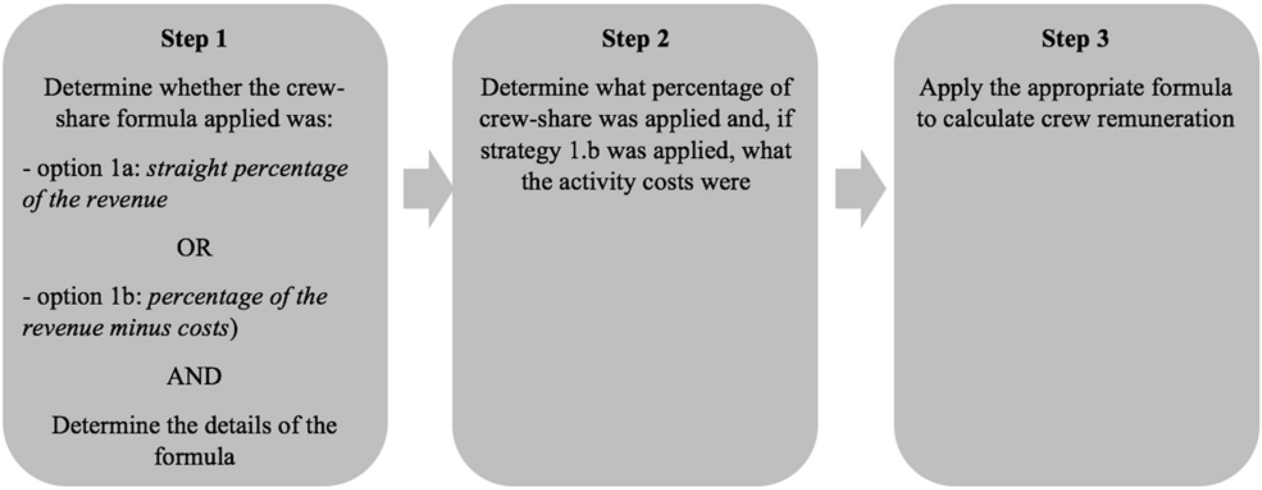

Figure 13. The three-step process to be followed when calculating remuneration via an indirect method that replicates the system used by the fishers themselves.

The first step in the collection process is to determine which form of the crew-share formula is being applied. It is necessary to determine the specific structure of the formula used for calculating crew remuneration. The general formula type must be determined as either 1a or 1b and then, the details of the formula − for example whether the costs were discounted before or after the crew-shares were determined, and whether there is a minimum salary which is topped up by the crew-share payment − must be ascertained. The second step is to determine the percentage or revenue assigned to the crew-share and the elements required by the formula for calculating crew remuneration. The four elements, shown below in Figure 4 are described and presented in ascending order, according to the difficulty of collecting them. They are: activity costs, crew-share percentage, revenues and crew remuneration.

There are varying levels of difficulty in the collection of the four elements resulting from a combination of the number of potential available sources for the element and the sensitivity of the information (as shown in Figure 14). Generally, people are more comfortable discussing costs and non-monetary issues than they are with discussing incomes. Reluctance to discuss income, and more specifically revenues, is likely to be caused by the fact that survey respondents may also be required to report this information to tax authorities and/or for fisheries management purposes, as discussed above.

According to the two dimensions of number of sources and sensitivity, the four elements range in overall difficulty in collection. All of the data can be collected through the same survey however, if that is not an option the items can be collected through different means, as explained below.

Of the four elements, the first, obtaining the crew-share percentage, is the least difficult. Aside from queries through surveys the information on crew-shares is widely known and freely discussed in fishing communities and, moreover, the same formula is often applied in the same areas and within fisheries. So, not only are there a large number of sources, the homogeneity of the formula makes cross-checking easy.

Activity costs are located between low−medium sensitivity and medium−high for the number of sources required to obtain the information (Villareal et al., 2004). Energy costs are one of the main components of the 'activity costs' and they can be sourced from administrative data like income statements and either indirectly derived or cross-checked from logbooks or VMS activity data as energy use is proportional to the vessel's activity. If the power of the engines and the activity level is known, then volume consumed can be easily estimated. Energy costs can be then calculated from volume multiplied by price and this allows more freedom in sourcing the information. The other components of activity costs are proportional to the activity level of the vessel, the volume landed, and the crew engaged, and these can be either derived or cross-checked against a variety of direct and indirect sources that are easily accessed. In sum, being costs, this information is not perceived to be sensitive.

The revenue data are of a medium level of difficulty as the information is sensitive, but it can be obtained from a variety of sources, depending on national contexts and the fishery. Revenue is a result of landings and so it is part of the targeted information collected in regular catch and effort surveys. As the revenue data are targeted by both socio-economic and catch and effort data collection programmes they are “transversal”. This allows either a sharing between the two programmes of the ‘collection-burden’ or for the components to be summed from each source to complete the revenue picture. Either option offers an advantage to both programmes. Administrative data from logbooks, sale notes and income statements can be used (this data is more robust and easily obtained when strong management regimes are in place).

The final element − crew remuneration − is calculated with the formula, using the three other elements that are easier to collect and verify.

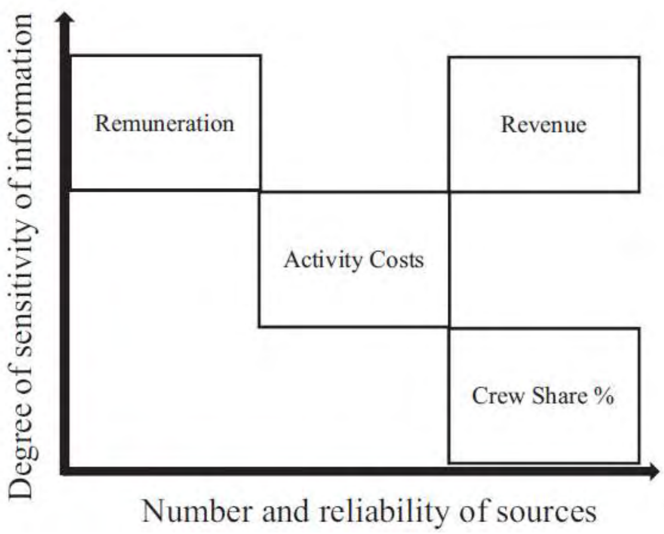

Figure 14. Relative degree of difficulty in obtaining the elements required by the formula for the calculation of crew remuneration under the crew-share system.

Four case studies to test the new methodology

In order to make a focused assessment of the utility of the novel methodology for determining crew remuneration, four case studies from Italian fisheries were conducted. Although the case studies pertain to Italian fisheries, the four fisheries are typical of Mediterranean fisheries with respect to the frequency with which owners are engaged on board; the application of crew-share systems; and remuneration formulas. The purpose was to examine the difference between the ledger values and the values calculated with the formula outlined above for four different fisheries: small-scale, trawlers, dredgers and pelagic longliners. Direct interviews arranged with the vessel owners through the respective cooperatives or producer associations from the regions of Sicily and Veneto in Italy. Vessels under each of the associations were randomly selected to be interviewed. 21 vessels were excluded following the screening question on whether they made use of the crew-share system as they did not use that system. The four fisheries were: dredgers operating under a quota system; the small-scale fleet in which the owner works on board almost every vessel; semi-industrial longliners; and the industrial trawl fleet. Interviews with 74 owners were conducted, 10 of whom were engaged in pelagic longline fisheries, 28 in small-scale fisheries, 16 in trawling and 20 in dredge fisheries.

The data collection was conducted following the novel methodology proposed here by first, collecting which crew-share formula was used. Next, data pertaining to the elements used in the formula were collected and then for the last step, the remuneration amount was calculated by applying the formula. The ledger and the formula values were collected during the course of the interview with the vessel owners who consulted their ledgers, therefore all elements collected for the comparison come from the same source and were collected at the same time. Ledger values for remuneration and elements including the number of crew per vessel and the occurrence of the owner working on board the vessel was also collected. The application of the correct formula and the resultant values were calculated on the spot and then confirmed with the vessel owners. All values were collected as annual figures for the year 2016.

Table 20 shows as all the vessel owners interviewed applied a form of the crew-share formula 1b where fuel and food costs were deducted in all of the cases. In addition to the fuel and food costs, the commercial costs were also deducted in the case of the pelagic longliners, dredgers and trawlers. Bait costs were deducted in the pelagic longline fishery, while the industrial trawl fleet deducted social security costs. For all of the fleets between 80 and 100 % of the vessels had the owners engaged on board the vessels. The crew share percentages applied had a narrow range between 50 to 52 % while, on the other hand, the range of values across the four fleet segments was quite wide for both revenue and activity costs.

Table 20. Employment and ownership characteristics of the four fleet segments

	Pelagic longliners	**Small-scale fleet**	**Dredgers**	**Trawlers**
Number of samples	10	28	20	16
Owner onboard the vessel (%)	90	100	80	80
Average crew/vessel	4.2	2.6	2.0	6.7
Revenue	264 641	74 472	64 005	560 154
Activity costs	54 267	14 025	9 428	201 199
Crew-share %	0.50	0.52	0.50	0.51
Activity costs components				
Fuel	x	x	x	x
Food	x	x	x	x
Commercial	x		x	x
Bait	x			
Social security				x
Formula used	1b	1b	1b	1b

A comparison was made with the ledger values recorded in the four Italian fleets against the value of remuneration calculated by means of the crew-share formula and this comparison is shown in Figure 15. In all of the fleet segments the same crew-share formula was applied:

formula 1b − where activity costs were deducted from revenue before the crew-share percentage. For each comparison, the value derived using the formula was higher than the value reported in the ledger, with the largest absolute difference observed in the trawler fleet (7 602 EUR). The largest relative difference was observed for the dredgers (50 % increase) and the range for the % difference of the mean values between 28–50 %, with the weighted average difference at 33 %.

The small sample size had a direct impact on the standard deviation values, along with a great amount of heterogeneity within the segments, and variable landing volumes and catch composition. Notwithstanding the impact on data quality resulting from the small sample size, there was a clear signal across the region within the fishery segments represented in the samples that the ledger values were consistently lower, and less accurate, than the values for remuneration calculated using the crew-share formula method.

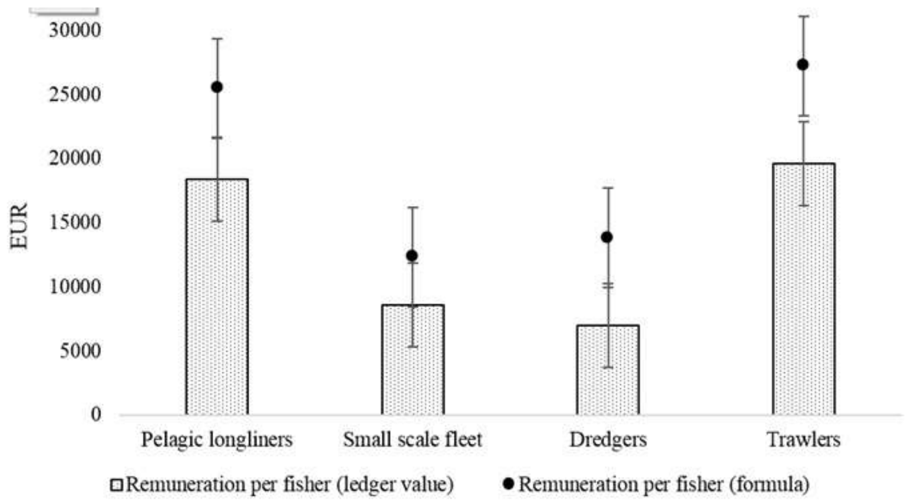

Figure 15. Remuneration per fisher values compared per fleet segment between ledger values and values calculated through the formula, showing standard error for the respective values.

4.1.5 Discussion

The evidence from the literature, for example, in France (Van Iseghem et al., 2011) and from the example presented in the Italian case studies supports the assertion that fisheries remuneration has not been accurately determined by conventional data collection methods. The lower accuracy primarily resulted from the fact that conventional methods usually rely on the values reported in the ledgers. The unstructured nature of many fisheries transactions demands an unconventional approach that facilitates a maximum level of detail to be captured, to replicate the means by which the fishers make their own calculations. The novel methodology presented here utilises this indirect approach to calculating remuneration. As detailed, the method consists of the identification and collection of the four elements required by the crew-share formula, each of which is associated with varying degrees of difficulty of data collection. A step-by-step process is followed whereby the elements of the formula that are easiest to collect are collected first: the crew-share percentage, the activity costs and, finally, the revenue. Although revenue is considered the most difficult element to collect, it is linked to landings data which provide a tangible source of information and, in the end, revenue is still easier to collect than remuneration. A shift in focus onto the collection of other elements, particularly revenue data, is enabled through the indirect calculation of remuneration and it also provides an opportunity to focus on improved data quality.

Revenues may also be underestimated or underreported and this further impacts the reporting of labour. The two main cost items are fuel and labour, but fuel costs are less elastic and readily verified by national and administrative data. This means that labour costs are vulnerable to being overestimated, especially as a mechanism so that costs could be adjusted to achieve an expected cost to revenue ratio. Evidence of such under-estimation is provided in the wider literature and is supported by the results of this exercise, making it clear that better quality data can be attained by using the formula values, rather than the ledger values.

Importance of remuneration as an indicator

Under the crew-share system, remuneration embodies the most important socio-economic characteristics of a fishery: it is an indicator of economic performance as well as an indicator of the contribution made by fisheries to the livelihoods of fishers, in the form of remuneration and employment. Under these conditions, remuneration can be used as an indicator that captures a measure of the quality and representativeness of the socio-economic data.

A handful of the mainstream indicators used in economic assessments of fisheries, such as return on investment and gross cash flow, have been criticised for not fully depicting the socio-economic conditions of fisheries. For example, in Boncoeur et al. (2000) it was proposed that return on capital, as a measure of performance, was not appropriate for assessments of economic performance and that returns on owner-operator labour would be a better indicator. In the case of gross value added, Prellezo and Iriondo (2016) raised that as an economic performance indicator it does not capture how the value-added is shared between labour and capital. In the literature of the field of fisheries economics, remuneration has often not had its full potential utility recognized and other, more conventional indicators have been given favour. The occasional reference to remuneration in the literature as a means of assessing the performance of fisheries placed a diminished emphasis on it as the definition and discussion did not include the crew-share system, nor were means for calculation included (Garcia et al., 2000). In small-scale fisheries labour is of the greatest order of importance and resultantly, remuneration is a more valuable indicator of economic performance than other measures which are more oriented towards capital returns or potential profits.

4.2 Labour-Related Indicators

Although labour-related indicators should be of paramount importance in a complete assessment of the socio-economic sustainability of the fisheries sector, they had only been minimally investigated in the study area of the Eastern Mediterranean prior to the inception of the FAO EastMed project, which began in 2009. The study in this section utilises the FAO EastMed project as a source of data. The data for all four countries, as detailed in the second chapter, was collected using comparable methodologies (Pinello and Dimech 2016) and this resulted in a high degree of data consistency and comparability, providing a unique opportunity for the compilation of national and regional comparisons.

4.2.1 Indicators in the case study countries

In 2012, across Italy, Greece, Lebanon and Egypt, the total number of active vessels in the fishing fleet was 32,362. According to the definitions of the GFCM and the EU (World Bank and FAO 2016; EU, 2010) vessels that did not work in 2012 were classified as inactive and excluded from the data presented here. The fleet segments analyzed for each country were the total fleet plus the segments present in at least three out of the four countries. The analyzed segments accounted for 97 % of the total number of vessels operating in the four countries. The fleet was dominated by the small-scale segment at 79 % of the total and this was followed by trawlers at 12 %. The relative proportion of the fleets for each country are shown in Figure 16.

In Greece and Lebanon, the small-scale segment was 94 and 95 %, respectively, of the total national fleet. In contrast, trawlers dominated the Egyptian fleet at 36 % of the total. In Italy, trawlers were the second largest segment after the small-scale segment. Lebanon was the only country without a trawl fleet (Pinello and Dimech, 2013). A combination of factors that include: a lack of government fuel subsidies; unsuitable bathymetry for trawling; regulations preventing fishing outside twelve nautical miles; and a ban on trawling within six nautical miles of the coastline (Pinello and Dimech, 2013) have all compounded to result in the absence of a trawl fleet in Lebanon.

The data from the four countries was treated in two groups. The first group considered all the active vessels in each country and the second group focused on the trawl segments of Italy and Egypt. The focus on the two countries was driven by the absence of a trawl fleet in Lebanon and the small number of Greek Trawlers. The trawl segments in Italy and Egypt were selected because of the large number of trawlers operating in the region and the fact that crew sizes on trawlers are typically large and more consistent over time. Vessel owners are generally not engaged on board trawlers which neutralizes this consideration around unpaid labour for skippers on board in the course of the data analysis. Further, trawlers also utilize the most homogeneous type of gear.

Values for the minimum wage (for the manufacturing sector) and the GDP per capita were extracted at a national level (Table 21). The total fishing fleet of the four countries employed approximately 80,000 people (Pinello and Dimech, 2013; Pinello and Dimech, 2016; FAO EastMed, 2014; STECF, 2016) corresponding to about 76,000 people on an FTE basis. Employment was further broken down to the average FTE per vessel. In general, the European countries had lower FTE per vessel, as was seen in the example of the small-scale fleet segment. In terms of activity, the number of days at sea ranged from Italy with 137 days to 193 days in Lebanon (Table 22).

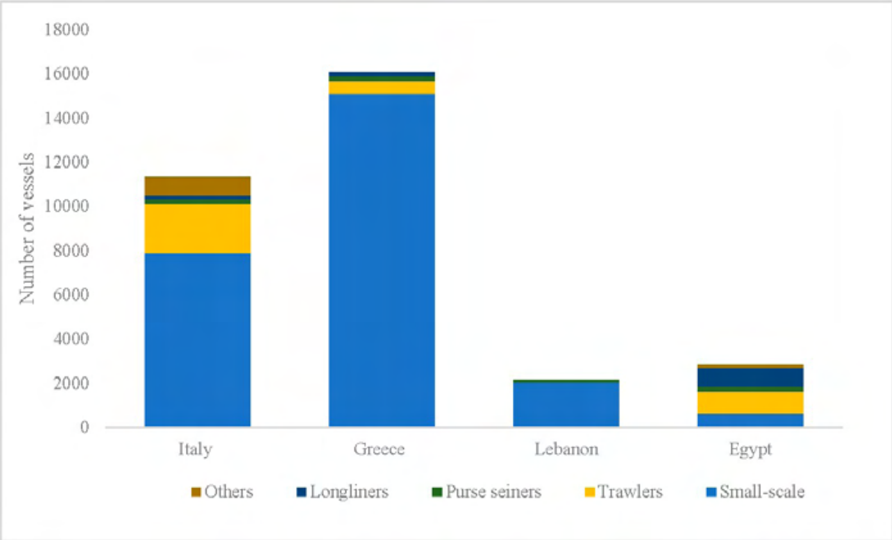

Figure 16. Relative proportion of fleet segments for each country, 2012.

Table 21. Minimum wage for the manufacturing sector and GPD per capita, 2012

Countries	Minimum Wage PPP (USD) [1]	GDP per Capita, PPP (USD) 1
Italy	21,967	35,525
Greece	9099	25,462
Lebanon	9003	16,871
Egypt	4591	10,248

[1] http://www.doingbusiness.org/data/exploretopics/labour-market-regulation.

Reported remuneration against the minimum sectoral wage of the country (REM) ranged from the lowest performance in Italy—where the average remuneration was 0.66 of the minimum sectoral wage—to Egypt where remuneration was 1.34 times the minimum sectoral wage. This pattern was consistent when the trawl fleet segments where considered as the performance in Italy was 0.78 of the sectoral minimum wage while in Egypt it was 1.47 times higher.

The highest LP, adjusted to PPP, was recorded in Italy and it was nearly three times higher than the other countries included in the analysis. For the trawl segment, the LP score was highest for Italy, at nearly 35,000 and in Egypt just over 13,000 (Table 22).

Table 22. Data extracted from the regional report A sub-regional analysis of the socio-economic situation of the Eastern Mediterranean Fisheries showing national totals and trawl-segment totals for Italy and Egypt.

Total Fleet						
countries	**Days at Sea (DAS)/Vessel**	**Total Employment on Board (FTE)**	**Employment per Vessel (FTE)**	**REM**	**LP (USD PPP)**	**GVA/Vessel (PPP)**
Italy	137	20,716	1.8	0.66	29,811	54,493
Greece	175	23,944	1.5	1.09	11,272	16,803
Lebanon	193	3704	1.7	0.82	10,730	18,590
Egypt	179	29,031	10.3	1.34	12,387	127,153
Trawlers						
	Days at Sea (DAS)/Vessel	**Total Employment on Board (FTE)**	**Employment per Vessel (FTE)**	**REM**	**LP (PPP)**	**GVA/Vessel (PPP)**
Italy	156	7370	3.3	0.78	34,934	114,852
Egypt	194	14,752	14.7	1.47	13,277	194,537

Source: Pinello and Dimech, 2016

4.2.2 Results and discussion

An index table has been used to present the results (Table 23) to facilitate ready comparison of the results with the base figure being set by the average for the group of countries.

Italy had the strongest labour productivity performance for both the national fleet average and for the trawler fleet, the most homogeneous segment. Labour productivity scores were relatively similar for Egypt, Greece and Lebanon. In contrast, Italy had the lowest performance for REM for both the national fleet level and for the trawler fleet. The highest REM performance was found in Egypt, followed by Greece and then Lebanon. In Greece the fallout from the 2008 financial crisis resulted in amongst, other matters, the minimum wage being lowered (Frick, 2016). As a result of this the current minimum wage was found to be low compared to the GDP. Employment per vessel was highest in Egypt at about 2.7 times the average; the remaining three countries performed similarly at under half the average, with the smallest value recorded in Greece as a result of the strong influence of the small-scale fleet. Egypt employed nearly five times more people per vessel than Italy in the countries' respective trawl fleets.

Lebanon and Greece both had the lowest recorded performed for the GVA per vessel while Egypt had a score that was seven times greater than the two countries and double that of Italy. The same pattern was evident between the trawl fleets of Egypt and Italy.

The comparison of the minimum wage for the manufacturing sector (adjusted to PPP) revealed that Italy had a minimum wage that was nearly two times the average, Greece and Lebanon were below the average and Egypt was under half of the average. The GDP per capita (adjusted to PPP) was above the average for Italy and Greece and below the average for Lebanon, and just under half of the average for Egypt.

Table 23. Data for the total fleet presented as index numbers where the average for the group of countries was set at 100.

countries	**Labour-Related Indicators**			**Performance Indicator**	**Macroeconomic Indicators**	
	LP	**REM**	**Employment per Vessel (FTE)**	**GVA per Vessel (PPP)**	**Minimum Wage (PPP)**	**GDP per Capita (PPP)**
Italy	186	68	47	100	197	161
Greece	70	112	39	31	81	116
Lebanon	67	84	44	34	81	77
Egypt	77	137	269	234	41	47

Labour productivity was first correlated against GVA and FTE- the first two factors in the formula to determine which factor was most responsible for driving performance (Table 24). The analysis showed that there was only a weak correlation between GVA and labour productivity, while there was a higher negative correlation between labour productivity and FTE. This would indicate that, in this regional example, FTE had a larger impact on the labour productivity performance.

Table 24. Spearman correlation of labour productivity and national GDP and remuneration across all of the fleet segments of the four countries (0.05 level of significance).

	GVA	FTE	GDP per Capita	REM
LP	0.07	−0.24	0.79	−0.65
FTE			−0.71	

An assessment made of the trawl fleets of Italy and Egypt between FTE/GDP per capita; LP/GDP per capita, LP/GVA; LP/FTE and LP/REM provided visual confirmation of this correlation (Figure 17). When labour productivity was correlated against the other labour-related indicator, REM, it was found to be negatively correlated and this was corroborated by a visual assessment of the two indicators for the trawlers in Egypt and Italy, as shown in Figure 17.

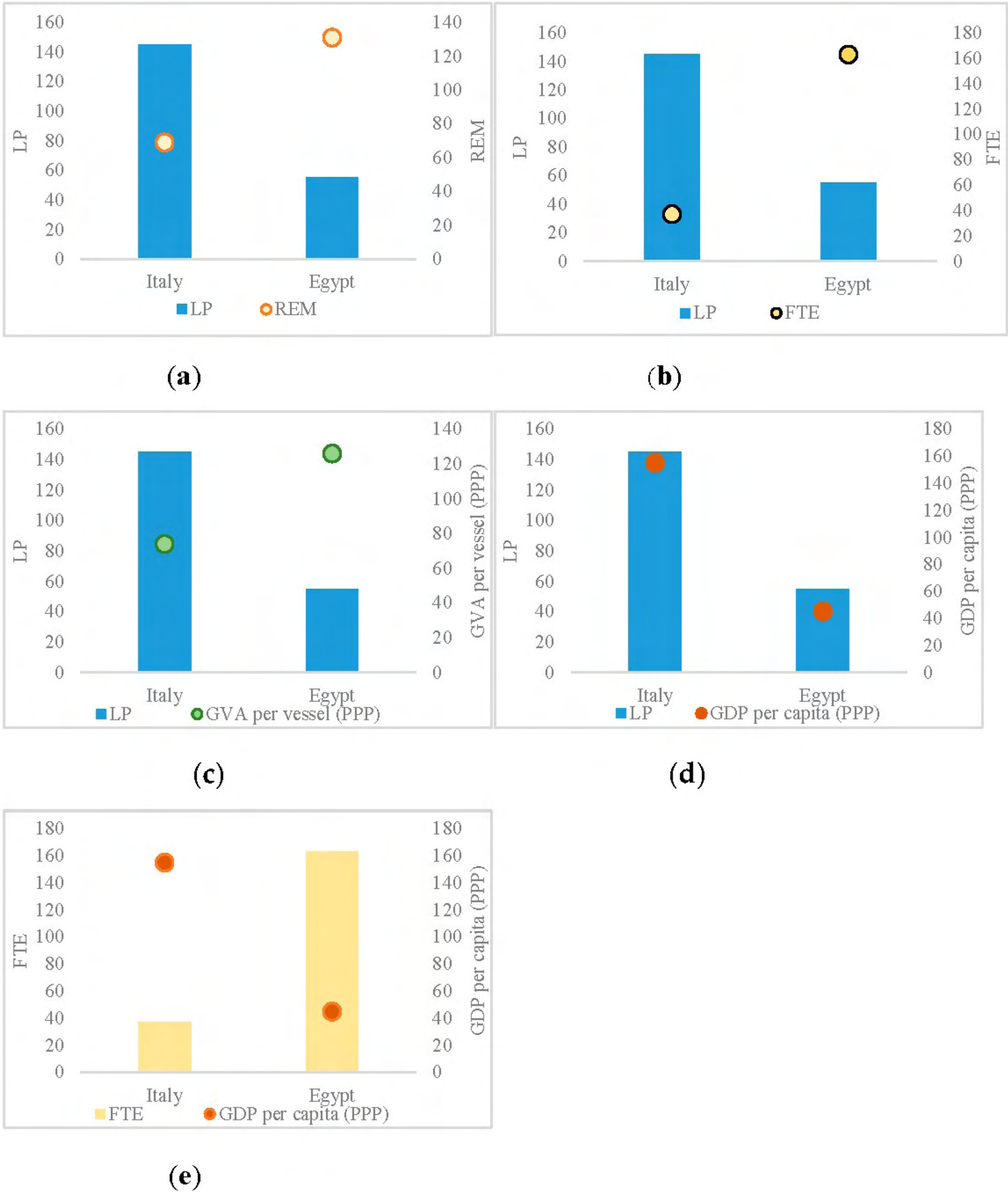

Figure 17. Comparison made using indicators from 2012 data for the trawl fleets, presented as index numbers where the average for the group of countries was set at 100. For the trawl fleets in Egypt and Italy the following indicators were compared: (a) Labour productivity and REM; (b) Labour productivity and FTE; (c) Labour productivity and GVA per vessel (PPP); (d) Labour productivity and GDP per capita (PPP); (e) FTE and GDP per capita (PPP).

GDP and minimum wage (PPP) are both presented in Table 21, however only GDP is included in the correlation calculation. This decision was motivated by the fact that minimum wage is readily influenced by contingent factors, as was pointed out in the example of

Greece, where the economy has been seriously affected by the financial crisis. Apart from in instances like these, minimum wage most often is a reflection of the GDP of a country. The correlation between labour productivity and GDP per capita (PPP) was positive and stronger than for the labour productivity against any of the other analyzed factors. The correlation was found to be −0.71 between FTE and GDP.

Although labour productivity is calculated by dividing GVA by the FTE, the FTE was still found to have a greater effect on the labour productivity score. The time worked is reflected in the measure of FTE employment and it is standardised against a fixed threshold of 2000 hours per year and this standardisation also neutralizes the impact on labour productivity scoring between the countries. The FTE was negatively correlated with GDP—the higher the income level, the higher the minimum wage for the sector and the lower the FTE in the fishery.

The fishing fleets of the countries included in the study all applied a crew-share system for remuneration- effectively an incentive scheme that provides motivation for the fishers' productivity. When the crew-share payment system is in place, reductions in the number of crew do not result in significant reductions in the labour cost component of vessels because the proportion of revenues assigned to the crew-share is a fixed ratio, no matter the number of crew members. Under these conditions and when the owner (who is the decision-maker for the vessel) is not on board the owners do not have any particular incentive reduce the number of crew on board. In any case, there is a threshold of remuneration per fisher above which the number of crew can vary but below which the number of crew has to be reduced in order to increase the attractiveness of work in the sector. Rephrasing this, if the proportion designated for the total amount of fishers' wages is a finite amount and as crew members are added the relative amount available per fisher decreases and this remuneration amount can only be reduced to a certain point, below which the fishers would not accept that amount for a wage.

Of note, the relative skill level of the fishers was too difficult to enumerate quantitatively and so this component was excluded as a factor in the analysis.

4.3. Overall results

In most fisheries worldwide, remuneration is made through a form of crew-share system rather than as a fixed wage. The crew-share system is prevalent in fisheries because it allows for risk and rent sharing, enhances productivity by providing incentives − particularly when the owner cannot monitor the fishers − and is also a traditional system that reflects the straightforward nature of effort inputs and catch outputs. The pervasiveness of the crew-share system is also a reflection of the reality of fisheries operations as the activity and its accounting are relatively simple, even though activity levels and outputs can be highly variable. When a crew-share system is in place, it is proposed that remuneration be calculated indirectly using the same formula applied by the fishers themselves. A comparison of ledger values against values calculated through the formula was made in four Italian fisheries and a clear underreporting of remuneration in the ledgers was recorded. Using the formula values for remuneration also allows for the occurrence of the owner working on board the vessel to be accommodated in the data, and for the complexity, sensitivity and frequency of informal transactions to be considered. All of these factors result in the derivation of more accurate data on remuneration.

Enhanced quality of data on crew remuneration is important for the assessment of a fishery for two reasons: it provides a tangible measure of the financial contribution that fishing provides to the livelihoods of the fishers; and, when crew-share systems are in place, crew remuneration is a straightforward indicator of the overall economic performance of the activity − crew-share payments are not separate from the gross profit of the fishing activity, but rather they are correlated to it so that better economic performance results in better remuneration for the crew. In this context, crew remuneration should not be considered as a classic input, but rather as an output of the activity. The methodology outlined here enables improved collection of remuneration data and contributes to better data quality for socio-economic assessments. The indirect calculation of remuneration allows for a shift in focus to the collection of the other elements and, in particular, revenue data and this provides the opportunity to also focus on improving the quality of that data. Finally, good quality data on remuneration and associated indicators is critical for improved management, decision-making and policy-making.

A general global trend has been identified, whereby an exit from work in primary sector occupations such as fishing follows an increase in national GDP. As the baseline for salaries increases, the "acceptable" income level also shifts upward. This was considered in this study through REM, that measured how attractive fisheries work is by comparing the average remuneration against the minimum wage and it was found that this matter of attractiveness drove the value for FTE. Mechanization plays an important role in improving the efficiency of landings per unit of effort and expediting the work on board fishing vessels. In addition, increased mechanization results in part from the declining attractiveness of the fisheries sector and a resultant reduction in the work force—which then drives increased mechanization. An example of the fluctuating attractiveness of work in the fisheries sector was provided by a study of the Lofoten fishery in Norway that spanned 130 years (Holm, 2010). The study showed that participation in fisheries fell off when the national economy achieved a high growth rate. Improvements in productivity in that fishery were partially attributed to technological improvements but were largely as a result of declining participation during good economic times (*ibid*). Typically, the higher the income level of the country, the lower the propensity to work in less attractive primary sector activities (Gallizioli, 2014; Mankiw, 2008). Changes in work preference, increases in alternative work options and shifting demographic patterns all broadly describe the labour-supply related causes for shifts in labour-supply curves (Mankiw, 2008). In simplistic terms, positive macroeconomic performance in a country increases the alternative work options, outside the primary sector, while increasing expectations about remuneration levels. This shifts the equilibrium point in the labour-supply curve and the number of workers in the labour pool is reduced (Mankiw, 2008).

Under the crew-share system, labour costs are not reduced by mechanization because the amount apportioned for the crew share remains relatively constant, regardless of the number of crew engaged. Reductions in FTE are not a result of increasing mechanization, but rather increasing mechanization is the result of a constricted labour pool. It is proposed that in the fisheries sector of the Mediterranean region, as in many other economic sectors, a paradigm links different factors: the higher the income level of the country, the lower the attractiveness of the fisheries sector and the employment per vessel, resulting in higher labour productivity levels. Conversely, the lower the income level of the country, the more attractive work in the fisheries sector is and so employment per unit levels are increased and labour productivity decreases. The asymmetrical policy landscape in the Mediterranean with European and non-EU countries falling under different policy and management schemes could also drive the LP performance. Particularly, under the CFP regime, which focused on reducing fleet capacities—and thereby the total number of vessels fishing—a reduced labour pool would be one result of the policies. Keeping all other factors constant, labour productivity increases can be driven by reductions in the number of people on board the vessel and this is really a result of external factors, including the macroeconomic conditions of the country.

Italy and Greece demonstrated the poorest performance for remuneration against the minimum wage and amongst the four countries examined in this study, Italy and Egypt presented the most contrasting cases. The labour productivity in Italy was relatively high, while the remuneration against the minimum wage was low, as was the average FTE per vessel. The reduced attractiveness of the sector has been broadly described in the context of the European Union (Gallizioli, 2014; Roussel et al., 2011; EC, 2016) and in Italy as supported by the relatively higher number of non-Italians working in fisheries (EC, 2016) and in other countries where the ratio of remuneration to the minimum wage is low. In Egypt, the average employment per vessel and the remuneration against the minimum wage were high, while labour productivity was lower. In this country, the fishing sector still offers attractive employment conditions, with relatively higher remuneration levels and higher levels of employment on board vessels. When considering the macroeconomic conditions that prevail in the countries, it was a logical fit that higher fisheries employment and lower labour productivity were identified in Egypt. Across all four countries there was a negative correlation between the performance of labour productivity and remuneration.

REM was found to be negatively correlated with labour productivity, although initially it may have been expected that they would be directly linked owing to the prevalence of the crew-share system which links productivity and remuneration. However, labour productivity is also related to the average number of crew members on a vessel. The maximum number of crew members employed on a vessel is largely determined by a mechanism that defines an adequate wage for work in the fisheries sector. Under the crew-share system, the percentage of revenue that is assigned to the crew-share remains constant no matter how many crew members are included. This means that the owner of the vessel does not have an incentive to reduce the number of crew because additional crew members have little to no impact on costs. What does limit the number of crew (within the bounds of what is required/possible for the vessel) is the size of each individual's remuneration when the total crew-share amount is divided into a greater number of shares. The upper limit for the number of crew is influenced by the requirement that remuneration does not drop below an adequate wage—here proxied with remuneration compared to the minimum wage.

From the analysis in this study, it would appear that the decoupling of productivity and remuneration that is common at the global and national levels, and normal in other economic sectors, is also a factor for fisheries. Labour productivity rates are strongly affected by macroeconomic factors outside the fishery itself, and in countries like Italy, these have resulted in labour force shortages and a consequent shift in fishing strategies towards less labour-intensive operations. In contrast, in Egypt, the macroeconomic conditions are different—there is a large labour pool and strong incentives to work in the fishing sector. Labour productivity appears to be a reflection of the economic situation of the country in which a fishery operates, rather than an objective that fisheries management should strive for, or a measure of livelihoods for the fishers. In order to best capture the socio-economic performance of a fishery, labour productivity should only be used to assess efficiency and should be paired with other indicators, like REM, to give a more complete assessment.

The value of these studies lies in the ability to compare countries with diverse socio-economic conditions that share similarities that include operating in a shared marine environment, and in some cases, share the same stocks and record similar rates of exploitation of these commons in the Mediterranean fisheries. Additionally, the utilization of data utilized which was collected with a comparable methodology, have resulted in high levels of data consistency, and provided an opportunity to draw meaningful comparisons between the countries.

In addition to proposing a novel methodology for collecting and utilizing remuneration based on crew-shares, the findings of these studies suggest that (i) labour productivity does not capture the contribution to livelihoods, using REM as a proxy; (ii) variations in performance for labour productivity appear to be the result of adaptations within fisheries to outside macroeconomic factors; (iii) the crew-share system makes labour costs a fixed share of the gross profits and the total amount of labour costs is fixed so, from the owner's perspective the number of crew members has a limited impact on profits. This to a large extent shifts the influence in the determination of labour productivity to the employment factor; and (iv) labour productivity should not be used as a stand-alone indicator, but should rather be considered in combination with other indicators. In summary, labour productivity would appear to largely be a reflection of the policy context in which a fishery is situated and the larger macroeconomic context of a country. The social sustainability of fisheries, which must be supported for effective policy regimes, is not particularly captured, nor supported, by LP and it is raised that labour productivity should not be considered a stand-alone indicator of the socio-economic performance of a fishery.

CHAPTER 5: CONCLUSIONS

5.0 Introduction

This final chapter summarises the results of the dissertation, the limitations and discusses the results in the context of policy implications. Finally, the chapter concludes with some potential future extensions that could be made from this research.

Until recently fisheries management has been primarily focused on management from a biological perspective and there has been a subsequent focus on the collection of biological data with little focus placed on the socio-economic component of fisheries. However, fisheries management cannot be truly effective if it does not take into account the main actors in fisheries – the fishers themselves.

Labour costs represent the main cost component for fisheries around the world, but without a sound knowledge of this component, the analysis of fisheries and fisheries management is weaker than it could be. Particularly, few studies have been made in the study area of this dissertation – the Eastern Mediterranean.

The true nature of the remuneration mechanism in fisheries has not always been correctly understood, and the labour component and the related indicators have not always been placed at the centre of socio-economic analyses.

The study used, primarily, data from four countries, Egypt, Lebanon, Italy and Greece, particularly selected because of the compatible data collection methodologies that resulted in a high degree of consistency and comparability. Further, the countries selected were chosen as the author was directly involved in the data collection. So, although data coverage was limited in terms of number of countries included, these countries had data of good quality and comparability.

The fact that the fishing fleets of the four countries all operate in the semi-enclosed Mediterranean Sea—and in some cases share the same stocks, while the countries all had diverse socio-economic conditions, and this provided an opportunity to draw meaningful comparisons between them.

The dissertation had one overall objective and three specific objectives. The overall objective was to further the understanding of labour related components in fisheries. The three specific objectives were: first, improve the methodology for the collection of socio-economic data; second, introduce a new methodology to calculate remuneration. Third, investigate the interplay between the labour-related indicators.

The methodology utilised in this dissertation was implemented in the region as detailed in the related technical publication from FAO (Pinello et al., 2017) and the labour-related portion of the methodology was developed in the course of the studies conducted for this dissertation. Nevertheless, this research is unique in that no other study has ever before empirically established the novel collection methodology for remuneration under the crew-share system and has generally conducted an analysis of the drivers of the labour indicators in the area.

5.1 Insights on the livelihoods of fishers

The study highlighted the importance, in terms of economics and employment generation from the fishing sector around the world.

Globally, there were an estimated 39.4 million fishers operating in all environments and 3.2 million fishing vessels operating in marine waters and in the Mediterranean, there were 93 000 fishing vessels with 221 797 fishers engaged in the primary sector. In 2012, the total estimated capture production was 79.7 million metric tonnes and in the Mediterranean it was approximately 1.2 million metric tonnes. In 2012, 54 % of the total, or 136 million metric tonnes were traded. The cost structure characterizes the fishing segments and is an important component in the analysis of fisheries. Labour makes up the main component of costs, and together with energy costs account for more than sixty % of the total operating costs for fishing vessels. In order to analyze the labour component in detail a set of indicators was selected covering employment, remuneration, labour productivity, and the macro-economic conditions.

Data was collected in the Mediterranean for these indicators by following the structure established by a well-defined methodology, which allowed the data to be comparable. Following all of the detailed steps different evaluations of efficiency were conducted and two main areas of efficiency were examined – technical and labour.

Globally, the majority of fisheries apply a form of crew-share system for the remuneration amount, rather than applying a fixed wage. The dissertation has been formed on this fundamental characteristic of fisheries. The primary motivation of the studies conducted for this work has been to investigate the forms of the crew-share system as well as its functioning mechanism and to propose an *unconventional* methodology to improve the quality of the estimates for this component. The *unconventional* methodology was defined as such for two motivations. In the first pass, the methodology proposed for the calculation was a deviation from the standard technique of simply collecting the value for labour costs recorded in the ledger. The application of the formula actually applied by the fishers, making use of more readily and accurately collected values for revenue and cost, resulted in more accurate remuneration values. In the second pass, the *unconventional* label was applied as it was proposed in this dissertation that remuneration be re-classified from an input cost for fishing operations to be an output derived from a calculation. The novel methodology has been one of the main outcomes of this work, and the assertion about its effectiveness was supported by an exercise comparing the reported ledger values with the remuneration values calculated using this methodology. This methodology contributes to increasing the quality for socio-economic assessments by improving the estimation of two components: the financial contribution that fishing provides to the livelihoods of the fishers and the overall economic performance of the activity. As crew-share payments are not separate from the gross profit of the fishing activity, but rather they are correlated to it so that better economic performance results in better remuneration for the crew.

Finally, a side-benefit of this methodology is that remuneration, when well calculated in this manner, drags along the main economic characteristic values with it and so it is an indicator of the overall quality of the data collection programme, *per se*.

The measure of productivity for fisheries used in this dissertation was the ratio of the production, measured as GVA per unit of labour, as measured by FTE. The standard theory states that labour productivity (LP) reflects the technology utilized for the fishing activity together with the motivation and skills of the fishers involved and typically, increases in LP have been viewed as positive outcomes.

Globally, a trend has been identified whereby an exit from work in primary sector occupations, such as fishing, follows an increase in national GDP. As the baseline for salaries increases, the "acceptable" income level also shifts upward and the attractiveness of work in the sector decreases and this reduces the labour pool. The sector compensates for the reduced labour pool by increasing productivity. In other words, a paradigm links different factors: the higher the income level of the country, the lower the attractiveness of the fisheries sector and the employment per vessel, resulting in higher labour productivity levels. This dissertation examined the paradigm to determine whether it could adequately capture the contribution to the livelihoods of fishers.

Across all four countries there was a negative correlation between the performance of labour productivity and remuneration and it appeared that LP was more affected by factors external to the fishing sector and more related to the macroeconomic conditions of the country. For example, in Egypt the average employment per vessel and the remuneration against the minimum wage were high, while LP was lower. In this country, the fishing sector offered more socially sustainable and attractive employment conditions, with relatively higher remuneration levels and higher levels of employment on board vessels. All results obtained were consistent and confirmed the importance of analysing the labour-related indicators as a suite.

Concerning labour productivity, the findings of the dissertation suggested that: (i) the contribution to livelihoods is not well captured by the labour productivity indicator; (ii) variations in its performance appear to be the result of adaptations within fisheries to outside macroeconomic factors; (iii) the crew-share system makes labor costs a fixed share of the gross profits and the total amount of labor costs is fixed so, the number of crew members has a limited impact on profits. This to a large extent shifts the influence in the determination of labor productivity to the employment factor; and (iv) labor productivity should not be used as a stand-alone indicator but should rather be considered in combination with other indicators.

5.2 Policy implications

The work conducted in this dissertation would not be of much interest if unsuitable for drawing policy prescriptions. In the author’s view the work on labour related indicators should be able to produce results which can be applied in the policy context. Purpose of this section is to explain the policy implications that the results will have in the understanding and positioning of socio-economic components for sustainable fisheries development

Three policy implications are identified. The first of the policy implications is related to improved quality of the data. The second is the imperative for a better understanding of labour related indicators. Finally, the importance of the influence of the macro-economic conditions on the performance of the labour related indicators.

Improved quality of the data

The results from this dissertation have indicated that the proposed methodology allows for real improvements in the socio-economic data. The labour component is the most important in the socio-economic domain of fisheries and an increase in the quality of remuneration data results in an overall improvement in the understanding of this. This will consequently imply better understanding the motivations for fishers' actions in the sector and consequentially the possibility of setting better policy directives.

The imperative for a better understanding of labour related indicators

There is a clear need to understand the conditions under which fishers are operating as fisheries management is about managing people, not fish.

The findings of the research identified the need to ensure the labour-related indicators be analyzed with more depth and with the performance anchored to the notion of livelihoods for fishers. There is an interplay between labor productivity and the employment component and labor productivity should not be used as a stand-alone indicator but should rather be considered in combination with other indicators to avoid creating a perverse outcome from policy directives that do not consider these interactions. From this comes the identification of a policy dilemma: is it better to improve productivity or to increase employment?

Consideration of the macro-economic conditions on the performance of the labour related indicators

Often fisheries management ignores the macroeconomic conditions of the country where the fisheries are situated – however, this has a strong impact. Returning to the question raised above, ‘is it better to improve productivity or to increase employment?’ policy makers can make the decision based on the national conditions on the area to prioritize - either the need to keep more people employed or the need to improve the economic efficiency. The analysis needs to take into consideration the larger forces outside the fisheries sector. This is a political question and can affect the use of incentives to support whichever objective is most desirable for the country.

Limitations

The purpose of this section is to indicate the limitations that the research encountered.

The few countries selected were chosen as the author was directly involved in the data collection. So, although a limitation was that the total data coverage in terms of total number of countries was limited, the countries that were included have very good quality data and the data was all collected in a comparable manner. Further, a general limitation of the study is the restricted availability of socio-economic data.

Several assumptions, mainly in the treatment of the crew as a group, rather than a heterogeneous body composed by individual, were made in the course of the studies conducted as part of the dissertation. Namely, remuneration was estimated for the entire crew, without distinguishing the different number of shares assigned to, for example, the deckhands and the skipper. The unpaid labour for owners working on-board was estimated and, when analyzing the efficiency, the skill level of the crew members could not be taken into account.

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APPENDIX 1: CONFERENCE PAPERS PRODUCED DURING THE COURSE OF THE INVESTIGATION

Pinello D., Liontakis, A., Sintori, A., Tzouramani I., Polymeros, K., (2014). Assessing the efficiency of bottom trawlers and small-scale fishing vessels in Greece. Presented at the *I International congress of applied ichthyology and aquatic environment*. 13th – 15th November. Volos, Greece.

Pinello, D., (2015). Are the social characteristics of the skipper affecting the efficiency of the Egyptian fisheries? Presented at the *XXII European Association of Fisheries Economics conference*. 28th – 30th April. Salerno, Italy.

Pinello, D., Polymeros, K., Marzocchi, B., Gee, J., Sabatella, R., (2016). Efficiency in the mixed fisheries: generalist versus specialist. Presented at the *XIV Greek Agricultural Economists Association (ETAGRO) conference*, 20th–21st October, Volos, Greece

Pinello D., Gee J., Polymeros K., (2016). Arrangement of a benchmark table for employment, salaries and labour productivity in Mediterranean fisheries. Presented at the *II International congress of applied ichthyology and aquatic environment.* 10th – 12th November. Messolonghi, Greece.

Gambino, M., Accadia, P., **Pinello, D.,** Russo, T., Malvarosa, L., Sabatella, E., Cozzolino, M., Sabatella, R., (2016). Towards an integrated Coastal Zone Management in Campania Region (Italy): a multidisciplinary approach to the analysis of coastal fishery activities and their socio-economic management. *II International Symposium New Metropolitan Perspectives.* 18th-20th May. Reggio Calabria, Italy.

Pinello, D., (2017). Fisheries socio-economic sample survey in Italy: the importance of the non-statistical aspects. Presented at the *XXIII European Association of Fisheries Economics conference*. 25th – 27th April. Dublin, Ireland