

## Article

# Use of a Delphi Panel to Determine the Degree of Implementation of Blue Economy in Spanish Ports

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**Abstract:** Environmental concerns have become important in the shipbuilding industry. The concept of the Blue Economy was linked to a new model of economic development based on regeneration, where the production of waste is seen as the possibility of creating a new activity, product, and employment. Nowadays, when we talk about the Blue Economy, it is from a much more transversal perspective, deeply linked to the maritime economic sectors. The aim is to develop these coastal productive sectors from a socially, economically and environmentally sustainable point of view. Due to the great development that the Blue Economy has experienced in recent years, it is considered appropriate to carry out a study of this economic model in the port sector. For this reason, this article analyses the Spanish port system, determining the most important dimensions for measuring the degree of development of the Blue Economy and indicators for each of them. It is concluded that the main emerging sectors in the Blue Economy are biotechnology, research and education, sustainable infrastructures and gastronomy and tradition. The final result of this article is the development of a tool which, by introducing certain data, provides the degree of implementation or development of the Blue Economy both at a general level for the port and at a specific level for each dimension.

**Keywords:** blue economy; indicators; port activity; port system; port ranking



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## 1. Introduction

The Blue Economy is a new model of economic development based on regeneration, according to [1], this model aims to achieve the correct functioning of ecosystems, with respect to the evolutionary trajectory, so that we can nourish ourselves with the knowledge, abundance and adaptation of nature. In the current situation, when waste is produced that can no longer be used for another productive process, it is discarded, thus wasting large amounts of potential resources and wasting energy. The Blue Economy points out that any waste, both material and energy, can be the source for developing a new economic activity that generates jobs and income to help society develop.

Therefore, the problem to be solved is not the production of waste but its wasteful use. This is the key answer to both the environmental and pollution challenge we face and the economic challenge of scarcity.

Nowadays, when we talk about the Blue Economy, we are talking about it from a much more transversal perspective, deeply linked to the maritime economic sectors. The development of these coastal productive sectors is sought from a socially, economically and environmentally sustainable point of view, in such a way that the human activities carried out must be managed to guarantee the health of the oceans and safeguard economic productivity [2].

The development of this economy, according to the European Union, will be carried out through Blue Growth, which is defined as a long-term initiative to support sustainable growth in the marine and maritime sectors. It highlights the possibility of harnessing the

potential of the oceans and seas as drivers of the European economy through innovation and growth [3].

As can be seen, the Blue Economy is a recent concept, there is currently not much research on the subject, let alone methods developed to evaluate its implementation in port activity.

Thus, the main objective of this article is to use a Delphi panel to find out the degree of implementation and development of the Blue Economy in Spanish ports and to enable measurement and comparison between the different ports in their port activities, both by sector and at the general level of the port.

A phased methodology has been followed, in which a literature review has been carried out, the most important indicators of the sectors have been identified, the importance of the indicators has been determined, and using the Delphi method, the results of the surveys have been analysed and assessed, proposing a scale of the data obtained to obtain the degree of implementation of the Blue Economy in the Spanish ports.

## 2. State of the Art

The Blue Economy is a new model of economic development. According to [1] the “Green Economy” has meant that companies invest more to develop the goods and services offered and that consumers pay more to get the same or even less to preserve the environment, this economy has not achieved the expected viability and that is why there is a need to look for a new development model for today’s society.

The Blue Economy is based on regeneration [1], this model aims to achieve the correct functioning of ecosystems, respecting the evolutionary trajectory, so that we can nourish ourselves with the knowledge, abundance and adaptation of nature. In the current situation, when waste is produced that can no longer be used for another productive process, it is discarded, thus wasting large amounts of potential resources and wasting energy. The Blue Economy points out that any waste, whether material or energetic, can be the origin for developing a new economic activity that generates jobs and income to help the development of society. Therefore, the problem to be solved is not the production of waste but its waste. This is the key answer to both the environmental and pollution challenge we face and the economic challenge of scarcity.

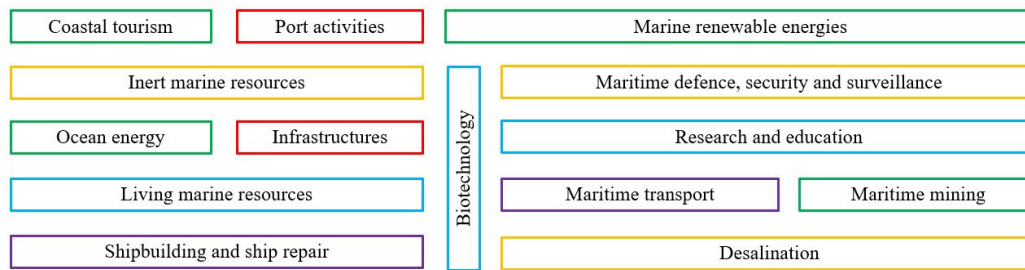
The mirror in which the Blue Economy looks is the natural world. Ecosystems are in an amazing balance where no resource is wasted, where the waste produced by one living thing is the raw material for another, and where the energy required is extracted from physics (gravity, pressure, temperature, etc.). These natural systems are not based on monopolies, the greater the abundance and variety, the more can be achieved with less. This is the fundamental principle of blue development, which is the antipode of the current model, based on what we do not have. In the words of [1] “by moving from a linear perception to a regenerative cyclical conception, we can also reshape our behaviours and practices to ensure that everyone’s basic needs are met and that our blue planet, with all its inhabitants, progresses towards an optimal future”.

The Blue Economy concept has become increasingly popular in recent years among institutions at different levels (European Union, United Nations, World Bank, national governments, etc.) and researchers around the world.

At the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012, the term Blue Economy was coined for the first time, defining the need for the oceans to be placed at the centre of attention, as it is necessary for green development efforts to evolve into a Blue Economy [4].

The Blue Economy is now a broad, cross-cutting concept, encompassing all economic activity related to the oceans. In terms of definition [5], it is common to use that which identifies the Blue Economy as a “platform for strategic, integrated and participatory development and protection of coasts and oceans, incorporating a low carbon economy, ecosystem approach and human well-being through the development of regional industries, services and activities”.

The European Union identifies the following 14 sectors (Figure 1).



**Figure 1.** Blue Economy sectors.

Ports, as the interface between the oceanic and terrestrial sides, play a fundamental role in the development of this economy through the different sectors mentioned above.

Institutions such as the European Union indicate that this economic development must be carried out through a strategy that is adapted to each specific situation. In the Communication “Opportunities for sustainable marine and maritime growth”, Blue Growth is identified as a long-term initiative to support the development of the maritime sector [3] that identifies Blue Growth as a long-term initiative to support sustainable growth in the marine and maritime sectors. It highlights the possibility of harnessing the potential of the seas and oceans as drivers of the European economy through innovation and growth. Blue growth opens the door to the ocean dimension of the Europe 2020 strategy, helping to increase the EU’s international competitiveness, creating jobs, safeguarding biodiversity and protecting the marine environment.

Blue Growth accounts for more than 5.5 million jobs and a GVA of 500 billion euros. On the other hand, many economic activities in the hinterland are highly dependent on ports and their development [6].

It should be noted that not many studies have dealt with the Blue Economy in ports. It is sufficient to look at the study carried out by [7], for the measurement of environmental development in ports through the Blue Economy. The researchers, using the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) and PICOS (Population, Interventions, Comparators, Outcomes, and Study) tools, established the search criteria for articles related to the environmental development of ports in five different databases. The results showed that only ten articles met the requirements, four of which were developed in Spanish institutions.

To begin the analysis, the economic development potential of each area must be known, since, as mentioned above, strategies must be adapted to each specific situation. In order to understand this potential, the following dimensions should be studied [8].

- Conditions for the establishment of the blue economy from the point of view of its three strands: social equity, economic viability and environmental sustainability.
- Availability of resources for the development of blue economy activities such as fisheries, aquaculture, ocean energy, coastal tourism, etc.
- Difference between enabling conditions and resource availability.
- Current capacity to establish an equitable, sustainable and viable Blue Economy (“Blue Economy Capacity”), based on the assessed indicators of environmental conditions and resource availability criteria.

The method used to obtain this final Blue Economy capability is fuzzy set distributions thus integrating a set of indicators from different disciplines. This fuzzy logic model evaluates each heuristic category (“sets”) representing very limited, limited, high and very high capacity for the corresponding Blue Economy criteria, dimensions and scores between 0 and 100. For example, a high average wind speed, existing infrastructure and a well-functioning economic system are expected to contribute to a higher capacity for offshore wind energy development.

Another important pillar to take into account in the Blue Economy is economic development. Certain sectors closely linked to ports and with a great specific weight, such as fishing or aquaculture, need reforms and fiscal incentives for their growth. It is common to use fiscal policy to carry out sustainable development from the three-dimensional point of view of society, the environment and the economy [9].

According to these authors there are three main fiscal tools for Blue Growth in these sectors:

- On the one hand, the taxes collected can be reinvested in the fisheries sector, thus regulating the input–output.
- When costs outweigh benefits, it is necessary to provide support to the sector (subsidies). Examples of such subsidies are fuel subsidies, subsidies for the construction and repair of vessels, etc. The European Union acts in this regard through the European Maritime Fisheries Fund, which in recent years has redirected these subsidies by promoting sustainability rather than capacity increase. For [8], the right subsidies are those that incentivise both growth and sustainability. A common problem with this tool is the poor distribution among small-scale fishermen.
- Ecological fiscal transformations. Sometimes the coastal jurisdiction protects environmentally valuable areas to the detriment of some sectors that needed their exploitation to survive, thus providing ecological benefits to society as a whole, beyond the area of influence of the maritime area in question. In these cases, it is necessary to incorporate an environmental performance indicator that quantifies the necessary fiscal transfers and aid to these sectors that have been deprived of the exploitation of these areas.

International organisations have also sought ways to assess the blue development of the maritime environment and its sectors through different tools. One example is blue bonds. These bonds are financial instruments that contribute to blue growth, which are used by different entities such as governments, private corporations, multilateral organisations, banks, etc., [10].

In terms of international experiences, the case of Greece stands out, where 25% of its economy is related to maritime transport and coastal tourism. This Blue Economy has lost competitiveness in recent years due to low wages and the health crisis generated by COVID-19. To reverse this situation, a panel of experts suggested the integrated implementation of plans for coastal management, environmental protection and economic growth; they identified a number of priority sectors for the Greek government to act on [11] port management, energy and marine resources, island competitiveness and entrepreneurship, and digital governance.

In this respect, the European Union, through various reports, provides the basis for achieving the objectives:

- Maritime Spatial Planning and its Land-Sea Interaction MSP-LSI (ESPON 2020): follow up of the Croatian coastal model aiming to identify the demands of the different stakeholders contributing to Blue Growth.
- Bridges (ESPON 2019): mainly dedicated to territories with geographical particularities such as islands in Greece. Enhancing the tourism and climate change sectors through blue, innovative and smart programmes.
- Ermes (ESPON 2021): focused on strengthening land-sea interaction to maximise benefits in the region of influence.
- Compass (ESPON 2018): comparative study of changes in governance models in territories, thus discovering new innovations, especially in the relations between European cohesion policies and local governments.

A number of examples of good practices for the development of the Blue Economy can be drawn from the above studies:

- Offshore energy development (North Sea): It is estimated that the North Sea alone could play a major role in decarbonising Europe's energy supply and provide up to 12% of the EU's electricity by 2030 [12].

- Intelligent navigation through automation, digitalisation and use of drones (Belgian ports).
- Land-sea interaction in cruise tourism (Croatia).
- Interreg MED project: classification of fishermen according to the recycling process of the waste generated.

European offshore wind energy has experienced strong and steady growth over the past two decades. By the end of 2016, 81 offshore wind farms with a total of 3589 offshore turbines had been installed and are connected to the grid in 10 European countries, giving a cumulative total of 12,631 MW. Offshore wind energy is the fastest growing sector of the blue economy and contributes significantly to employment growth in Europe, with 160,000 jobs, more than the European fishing fleet.

The five European countries with the largest installed offshore wind capacity are on the edge of the North Sea. The UK tops the list with the largest installed offshore wind capacity in Europe, accounting for 40.8% of all installations. Germany follows with 32.5%. Denmark remains the third largest market with 10.1%, with the Netherlands (8.8%) and Belgium (5.6%) following in fourth and fifth place respectively. These countries account for 97% of all grid-connected turbines in Europe [13].

The strong development in the five countries mentioned above is largely due to Maritime Spatial Planning (MSP). MSP and wider sea basin strategies are also seen as key mechanisms to harness the renewable energy potential of European seas, facilitating efficient connectivity and energy distribution between nations [14].

Offshore wind energy raises a number of land-use planning issues. These include: The provision of adequate offshore space for wind farm development; the provision of manufacturing and assembly sites near the coast or in ports (and manufacturing complexes elsewhere); the provision of grid connection points (and associated high-power cabling); and the provision of operational space associated with ongoing maintenance.

In terms of experiences in Spanish ports, the Port Authority of Motril has set out to develop and manage its public domain in harmony with its environment in an efficient manner through innovation and sustainability. It distinguishes the following pillars [15]:

- Infrastructure: development of new infrastructure without harming native species through translocation to safe areas with the help of the University of Seville, cogeneration engines and electrical connection of ships in the port, thus reducing emissions [16] and zero-energy buildings.
- Development of efficient intermodal transport.
- Innovation: organisation of visits by school groups to the port where current and traditional activities are shown, open day for individuals, Wi-Fi Internet access in the facilities and technological development in the port's management processes.
- Sustainability: development of good practice guides for cargo handling, waste collection plans and publication of a port sustainability report [17].
- Environment: training plans for the future port sector, pollution reduction in collaboration with the University of Granada, dual vocational training with local high schools, support for cultural and sporting activities, visits to the fishing port, etc.

As a benchmark at European level, the port of Vigo shows a clear strategy for the promotion of the Blue Economy through different sectors. For the period 2021–2027, 44 actions have been identified in whose definition both public bodies and private entities in the port's area of influence have collaborated [15]. These actions are integrated into four main pillars: Connected Port, Innovative Port, Green Port and Inclusive Port.

The most important sectors in which the different projects will be developed are:

- Freight and Maritime Transport
- Fresh and Frozen Fish
- Shipbuilding
- Biotechnology and Blue Energy
- History and Training



- Cruise traffic

Some of the most outstanding projects were presented at the Green Energy Ports Conference 2021 in the port of Vigo (More information about: <http://bluegrowthvigo.eu/proyecto/green-energy-ports-conference-es>; accessed on 24 September 2021). With the aim of reducing the emissions produced in the port, using geo-referenced information tools, the optimal locations for the placement of renewable energy infrastructures (windmills, photovoltaic panels, etc.), were estimated, thus ensuring the energy self-sufficiency of the port facilities [18].

At the same conference, [19] presented the objective of being a zero-emissions port by 2030, thus aligning the port's strategies with the EU Green Deal and the SDGs of the United Nations. To this end, through the analysis of the carbon footprint, the origin of the emissions and the areas of action to reduce them were observed. Three main lines of action were identified:

- Improving energy efficiency and renewable energies
- Use of cleaner alternative energies: LNG/Cold Ironing/Hydrogen.
- Seabed regeneration and natural CO<sub>2</sub> sequestration

Another specific measure taken, in addition to the objective of energy self-sufficiency mentioned in the previous paragraph, is the contract formed with an electricity company in which it is guaranteed that the energy supplied to the port comes from 100% renewable sources.

In the field of environmental integration of infrastructures, designs that facilitate the colonisation of organisms and their monitoring have been promoted owing to the collaboration with the University of Vigo. Port-city interaction has also been encouraged, reducing the tension produced by the space through the integration of urban environments and natural spaces, on the other hand, the so-called e-concrete has been used, a material that is less aggressive with the environment and which facilitates the appearance of colonies of marine organisms [20].

In the case of Barcelona, the combined efforts of public and private investment will facilitate the success of projects oriented towards the blue economy. To this end, the Port Authority of Barcelona is seeking the development of start-ups and international scientific companies and networks to attract investment to the port through the creation of a technology hub [21].

Port de Barcelona also promotes initiatives related to regeneration and biotechnology through the treatment of marine structures such as wind turbines or degraded docks by installing calcium carbonate structures that allow fish and algae to form colonies on these pieces.

With the aim of reducing greenhouse gas (GHG) [22,23] emissions, the Port Authority of Barcelona will allocate 110 million euros until 2030 as part of the "Nexigen" programme for the electrification of docks to meet the energy needs of ships during berthing [24].

On the other hand, the Strategic Plan for the port of Castellón covering the period 2020–2024 proposes a series of strategic objectives (19), operational objectives (23) and initiatives (57) in which Blue Economy sectors such as innovation and digitalisation, energy efficiency, etc., are supported.

The aim is to give a boost to the fishing sector, to the development of new industrial activities that not only affect the port but also society as a whole. The port's Blue Growth places people's respect for the environment and innovation at the heart of the project [25].

The Port Authority of Santa Cruz de Tenerife is carrying out works in the port of Granadilla to create a benchmark energy hub in the area, and is also looking for ways to develop renewable energy production in the Authority's installations [26].

Until 2023, the Basque Country will allocate two million euros to the project "Technological and Industrial HUB for the Development of the Blue Economy in the Oarsoaldea" in order to promote the technological and research sectors aimed mainly at the study of climate change and the circular economy. The objectives can be summarised as follows:

- Facilitating the creation of start-ups
- Development of employment, oceanographic conditions and material resistance services for off-shore developments, or high value-added marine products.
- Support the fisheries, aquaculture, tourism and ocean energy sectors.
- Increased maritime safety in order to be aware of the situations occurring at sea and to be able to ensure proper spatial planning and efficient management of activities.

This promotion of the Blue Economy forms part of the axes of the 2017–2025 Strategic Regional Plans [26].

### 3. Objective and Methodology

#### 3.1. Objective

As mentioned above, the main objective of this article is to find out the degree of implementation and development of the Blue Economy in Spanish ports, in their port activities, both by sector and at a general port level, which will allow measurement and comparison between different ports, by means of a Delphi panel designed for this purpose.

#### 3.2. Methodology

The methodology followed, developed in phases, is set out below:

Phase 1: Bibliographic review to find out about the studies and advances that exist to evaluate the development of this economy in the maritime field in general and in ports in particular, such as the development potential of the blue economy in a given area and the economic, fiscal, and environmental policies carried out. On the other hand, a compilation of national and international experiences will be made in order to find out what kind of measures to develop the Blue Economy are being carried out at port level. This will lead to the identification of the Blue Economy sectors that are most closely linked to ports. Once the dimensions or sectors have been identified, a group of between 4 and 5 indicators will be determined for each of them owing to the literature review and the experiences being carried out in certain Spanish ports.

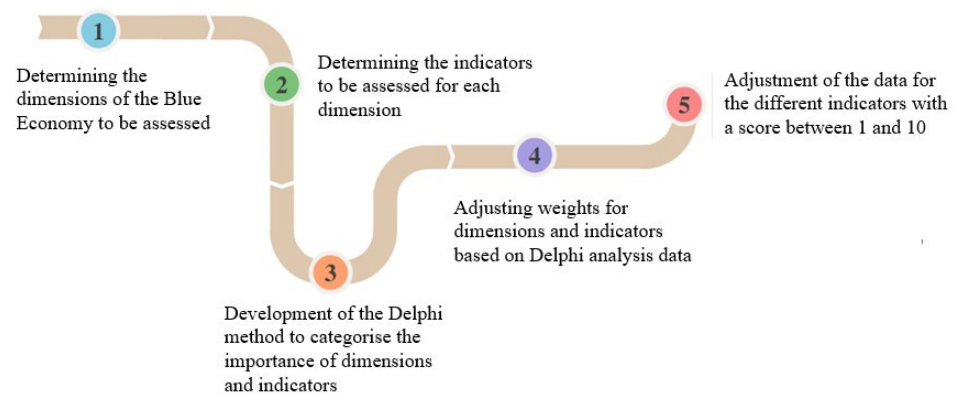
Phase 2: Identification of the most important indicators of the sectors defined above, based on the Spanish experience and bibliographical references.

Phase 3: Determination of the importance of the indicators within each dimension or sector and the classification of the dimensions will use the Delphi method, which is a tool that organises a process of dialogue between different experts in a specific field where an anonymous feedback effect is produced. More than 30 experts from the port sector participated. The dialogue process was carried out by means of two rounds of electronic surveys in which the questions to be answered were to rank indicators and dimensions from highest to lowest according to the importance they considered to be in their expert opinion.

Phase 4: Analysis and assessment of the results of the surveys in order to give a weighting to each indicator and dimension.

Phase 5: Proposal of a scale option for the port data with a score between 1 and 10 which, when multiplied by the value of the indicators, gives the degree of implementation or development of the particular dimension of the Blue Economy and the aggregate of all the dimensions to obtain the development of the port as a whole.

Figure 2 is an outline of the procedure to be followed in this research work.



**Figure 2.** Outline of the research.

#### 4. Analysis of Results

According to the bibliographic review carried out on the basis of the 14 sectors identified by the European Union, and considering which are most applicable to port activity, the following have been considered: inert marine resources (mainly oil and gas extraction), port activities (stowage and unstowage of goods and passengers), ship construction and repair, desalination, maritime mining and defence, maritime security and surveillance. The selected sectors are set out below (Table 1).

**Table 1.** Dimensions of the Blue Economy considered.

| Dimension                           | Description                                                                                                                                                                                                                                                                                                           |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Living marine resources (fisheries) | Includes all activities related to large-scale and small-scale capture fisheries and aquaculture, as well as their processing and manufacturing.                                                                                                                                                                      |
| Renewable energies                  | This dimension is clearly growing and includes everything related to electricity generation through renewable energies: off-shore wind power, tidal power plants, floating photovoltaic plants, etc.                                                                                                                  |
| Coastal tourism                     | The most important sector of the blue economy in terms of GDP and employment at European level and especially in Spain. Ports play a key role in the growth of tourism in coastal areas.                                                                                                                              |
| Biotechnology                       | Through research, the aim is to encourage the use of biomass (algae, bacteria, fungi, etc.) for commercial applications such as food, cosmetics or fertilisers and for innovative developments such as biomaterials and biofuels.                                                                                     |
| Research and education              | Raising awareness and implementing integrated knowledge on the impacts of climate change on marine ecosystems, preserving and sustainably exploiting marine and coastal ecosystems, de-risking investments to improve access to blue innovation and developing smart and connected land-sea territories.              |
| Sustainable infrastructure          | It includes port infrastructures that contribute to sustainable development, for example: development of infrastructures that require less energy consumption, rehabilitation of areas for the development of indigenous ecosystems, processes of relocation of species in areas affected by new infrastructure, etc. |
| Gastronomy and tradition            | Encouragement of the local and traditional gastronomy of the area, recovery of traditional activities and their promotion to the general public and schoolchildren.                                                                                                                                                   |

##### 4.1. Determination of Indicators to Assess Each Dimension

Various publications present different indicators for the above mentioned sectors of the Blue Economy. In order to develop the list of indicators for the present article, publications



such as Refs. [27,28] and the study of activities were carried out for the autonomous ports in the Valencian Community (Spain) [29]. The indicators are summarised in Table 2.

**Table 2.** Indicators used.

| NO. | Indicator                                               | Unit |
|-----|---------------------------------------------------------|------|
| 1   | Number of jobs generated in the port                    | NO.  |
| 2   | Turnover                                                | €    |
| 3   | Installed renewable energy capacity                     | MWh  |
| 4   | Degree of electrification with renewables               |      |
| 5   | Investment                                              | €    |
| 6   | Renewable energy consumption as a share of total        |      |
| 7   | Amount of fishing                                       | t    |
| 8   | Collaboration with universities and/or research centres | NO.  |
| 9   | Sustainable activities                                  | NO.  |
| 10  | Activities with schoolchildren                          | NO.  |
| 11  | Traditional activities                                  | NO.  |
| 12  | Establishments (maritime museum, yacht club, etc.)      | NO.  |
| 13  | Number of beds for accommodation                        | NO.  |

Once the selection criteria for both the dimensions of the Blue Economy to be evaluated and the indicators for these dimensions have been set out, the following table shows the distribution of the indicators for each of the dimensions to be evaluated. The distribution is shown below (Table 3).

**Table 3.** Dimensions and indicators.

| Dimensions                                | Indicators                                                                                                                                      | Title 3 |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Living resources (fisheries, aquaculture) | jobs generated in the port                                                                                                                      | No.     |
|                                           | turnover (% of the total of the port)                                                                                                           |         |
|                                           | investment                                                                                                                                      | €       |
|                                           | quantity of fish caught                                                                                                                         | t       |
| Renewable energies                        | jobs generated in the port                                                                                                                      | No.     |
|                                           | renewable energy consumption as a share of total                                                                                                |         |
|                                           | investment                                                                                                                                      | €       |
|                                           | installed capacity of renewables                                                                                                                | MWh     |
| Tourism                                   | jobs generated in the port                                                                                                                      | No.     |
|                                           | turnover (% of the total of the port)                                                                                                           |         |
|                                           | number of establishments (commercial, sports, etc.)                                                                                             | No.     |
|                                           | sustainable activities (sailing school, etc.)                                                                                                   | No.     |
| Biotechnology                             | number of beds for accommodation in the municipality                                                                                            | No.     |
|                                           | jobs generated in the port                                                                                                                      | No.     |
|                                           | investment                                                                                                                                      | €       |
|                                           | collaboration with universities and/or research centres                                                                                         | No.     |
| Research and Education                    | sustainable activities (facilities such as algae farms, biomass farms, cosmetics, etc.)                                                         | No.     |
|                                           | jobs generated in the port                                                                                                                      | No.     |
|                                           | investment                                                                                                                                      | €       |
|                                           | collaboration with universities and/or research centres                                                                                         | No.     |
| Sustainable infrastructures               | activities with schoolchildren (schools, high schools, etc.)                                                                                    | No.     |
|                                           | jobs generated in the port                                                                                                                      | No.     |
|                                           | investment                                                                                                                                      | €       |
|                                           | degree of electrification with renewables: electrification of ship's services during berthing, use of renewable energy in other port facilities | No.     |
| Gastronomy and tradition                  | sustainable activities (digitisation, promotion of ecosystems in port structures, etc.)                                                         | No.     |
|                                           | jobs generated in the port                                                                                                                      | No.     |
|                                           | investment                                                                                                                                      | €       |
|                                           | existence of a maritime museum                                                                                                                  | Yes/no  |
|                                           | traditional activities (promotion of traditional fishing methods, local gastronomy, etc.)                                                       | No.     |

#### 4.2. Ranking of Dimensions and Indicators: Delphi Method

Once the dimensions and their indicators have been established, it is necessary to classify their importance in order to obtain in the following steps of the study the weight that dimensions and indicators have in the Blue Economy development assessment tool.

The Delphi method was used to elaborate this ranking, as the subject of this work is new and there are no major advances or references to date, therefore, this methodology fits the research. The objective is to obtain greater inter-subjective and prospective knowledge on the subject matter [30].

The Delphi method is a tool that organises a process of dialogue between different experts in a specific field in which an anonymous feedback effect is produced to develop a specific research problem [31].

The selection of experts is a key point for the correct development of the Delphi given that the results obtained are linked to these experts. In the present study, the participating experts can be divided into two main groups: experts from the Spanish port system, university professors of the E.T.S.I. Caminos, Canales y Puertos (Polytechnic University of Madrid). As it is a relatively homogeneous group, the number of experts needed to develop the panel would be 10 to 15 [32]. On the other hand, there are also authors who propose a higher number, between 15 and 35 participants [33].

The development of the Delphi tool in this study was carried out by means of an electronic survey using the Microsoft Forms application, with two rounds being carried out among the different experts. In the first round, 34 people took part, while in the second round the number of participants was reduced to 25. The following questions were asked in the survey:

- Rank the 7 dimensions of the Blue Economy studied in this paper from highest to lowest according to their level of importance.
- For each of the dimensions, rank order your indicators. For this purpose, 7 different questions were elaborated with the options for the indicators summarised in Table 3.
- At the global level, rank the indicators from most to least important, regardless of the dimension to which they belong.

#### 4.3. Development of the Evaluation Tool

Once the ranking in importance of the dimensions at a general level and of the indicators of each dimension has been obtained owing to the Delphi method, we proceed to assign a weight to each one of them, following the method used by [33].

As there are seven dimensions, a value from 1 to 7 is given according to the position obtained in the survey, so that the dimension considered by the experts to be in first position is given 7 points, the dimension considered to be in second position is given 6 points, and so on until the last dimension is given 1 point. The results are shown in Table 4.

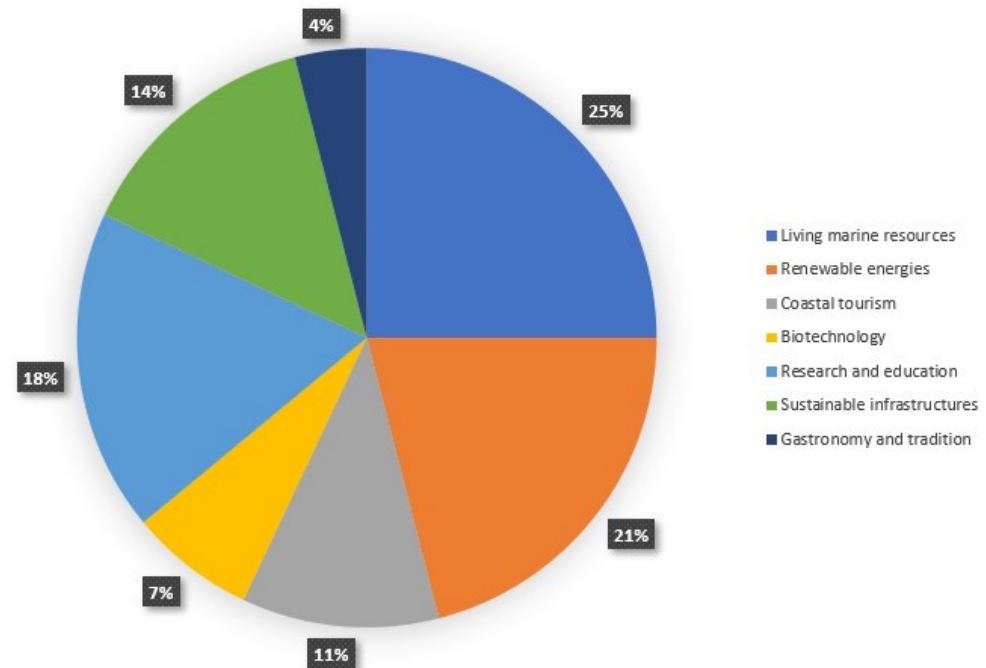
**Table 4.** Positions and points awarded for the studied dimensions.

| Dimensions                                | Positions | Points |
|-------------------------------------------|-----------|--------|
| Living resources (fisheries, aquaculture) | 1         | 7      |
| Renewable energies                        | 2         | 6      |
| Tourism                                   | 5         | 3      |
| Biotechnology                             | 6         | 2      |
| Research and Education                    | 3         | 5      |
| Sustainable infrastructures               | 4         | 4      |
| Gastronomy and tradition                  | 7         | 1      |

Once the weighting points have been awarded, the value of each dimension is calculated using the following equation:

$$\text{Dimension value} = \frac{\text{weight of the dimension}}{\sum_{i=1}^n \text{weight of the dimensions}} \times 100$$

The results can be seen in Figure 3.



**Figure 3.** Value (%) of each dimension.

The same method was used to calculate the value of each indicator in each of the 7 dimensions. First, a score has been given according to the position of the indicator in the results of the expert surveys. The maximum score varies between 4 and 5 points depending on the number of indicators in each dimension. The following equation is then applied to obtain the value of the indicator within that dimension.

$$\text{Indicator value} = \frac{\text{weight of the indicator}}{\sum_{i=1}^n \text{weight of the indicators}} \times 100$$

Once the tool has been calibrated to measure the degree of development of the Blue Economy, both by dimensions or sectors and at the global level of the port, it is also necessary to adjust the data linked to each indicator by evaluating them from 1 to 10 so that when multiplied by the value of the indicator, a final score is obtained for the dimension of the indicator, ranging from 1 (very low degree of development) to 10 (maximum degree of development).

The proposed rating of each data point for the indicators is set out as follows:

Number of jobs generated in the port: 1 point will be awarded for each ten jobs generated in the sector/dimension studied up to a maximum of 10 points.

- Turnover: 1 point will be awarded for each tenth of the turnover of the sector in the port.
- Installed capacity of renewable energy: 1 point will be awarded for every 10 MWh installed up to a maximum of 10 points.
- Degree of electrification: 5 points will be awarded for electrification of docks and 5 points for electrification of other services (administration, yacht club, etc.,) up to a maximum of 10 points.

- Investment: 1 point will be awarded for each million euros invested in the sector up to a maximum of 10 points.
- Quantity of fish caught: 1 point will be awarded for every 1000 tonnes of fish caught/generated in the port up to a maximum of 10 points.
- Collaboration with universities and/or research centres: 10 points will be awarded if such collaboration takes place and no points if there is no collaboration at all.
- Sustainable activities: 2 points will be awarded for each activity carried out up to a maximum of 10 points.
- Activities with schoolchildren: 10 points will be awarded if such activities are carried out and no points if there are no activities at all.
- Traditional activities: 10 points will be awarded if such activities are carried out and no points if there are no activities at all.
- Existence of establishments: 2 points will be awarded for each establishment located in the port up to a maximum of 10 points.
- Existence of a maritime museum: 10 points will be awarded if this leisure facility exists and 0 points if the port does not have one.
- Number of beds for accommodation: 1 point will be awarded for every 3500 beds available in the municipality for tourism up to a maximum of 10 points.

The tool is summarised in Table 5, in which the indicator data should be entered in the quantity column (green column) scaled from 1 to 10. Multiplying by the indicator value (blue column) gives the result (yellow column). Adding the values obtained for each dimension gives the degree of development of the dimension. If these values are multiplied by the weight of each dimension (Figure 3) and added together, the degree of development of the Blue Economy of the port under study is obtained.

To obtain the degree of development of the Blue Economy in a port, the following mathematical expression is sufficient:

$$\text{Degree of development of the Blue Economy} = \sum_{j=1}^m \varphi_j \times \left[ \left( \sum_{i=1}^n (\alpha_i \times \beta_i) \right) \right]$$

where:

$\varphi$ : value of the dimension

$\alpha$ : value of the indicator

$\beta$ : quantity of the indicator

m: number of dimensions studied

n: number of indicators of the dimension.

**Table 5.** Summary of how the tool works.

| Dimension                                 | Indicators                                       | Position | Weight | Indicator Value (%) | Quantity                                      | Result           |
|-------------------------------------------|--------------------------------------------------|----------|--------|---------------------|-----------------------------------------------|------------------|
| Living resources (fisheries, aquaculture) | Jobs generated in the port                       | 1        | 4      | 40                  | Values to be determined by the Port Authority | Results obtained |
|                                           | Turnover (% of the ports' total)                 | 4        | 1      | 10                  |                                               |                  |
|                                           | Investment                                       | 3        | 2      | 20                  |                                               |                  |
|                                           | Quantity of fish caught                          | 2        | 3      | 30                  |                                               |                  |
| Degree of development of the dimension    |                                                  |          |        |                     |                                               |                  |
| Renewable energies                        | Jobs generated in the port                       | 3        | 2      | 20                  | Values to be determined by the Port Authority | Results obtained |
|                                           | Renewable energy consumption as a share of total | 1        | 4      | 40                  |                                               |                  |
|                                           | Investment                                       | 4        | 1      | 10                  |                                               |                  |
|                                           | Installed capacity of renewables                 | 2        | 3      | 30                  |                                               |                  |
| Degree of development of the dimension    |                                                  |          |        |                     |                                               |                  |

Table 5. Cont.

| Dimension                   | Indicators                                              | Position | Weight | Indicator Value (%)                    | Quantity                                      | Result           |
|-----------------------------|---------------------------------------------------------|----------|--------|----------------------------------------|-----------------------------------------------|------------------|
| Tourism                     | Jobs generated in the port                              | 1        | 5      | 33                                     | Values to be determined by the Port Authority | Results obtained |
|                             | Turnover (% of the ports ' total)                       | 2        | 4      | 27                                     |                                               |                  |
|                             | Number of establishments                                | 3        | 3      | 20                                     |                                               |                  |
|                             | Sustainable activities                                  | 5        | 1      | 7                                      |                                               |                  |
|                             | Number of beds for accommodation                        | 4        | 2      | 13                                     |                                               |                  |
|                             |                                                         |          |        | Degree of development of the dimension |                                               |                  |
| Biotechnology               | Jobs generated in the port                              | 2        | 3      | 30                                     | Values to be determined by the Port Authority | Results obtained |
|                             | Investment                                              | 3        | 2      | 20                                     |                                               |                  |
|                             | Collaboration with universities and/or research centres | 4        | 1      | 10                                     |                                               |                  |
|                             | Sustainable activities                                  | 1        | 4      | 40                                     |                                               |                  |
|                             |                                                         |          |        | Degree of development of the dimension |                                               |                  |
| Research and Education      | Jobs generated in the port                              | 3        | 2      | 20                                     | Values to be determined by the Port Authority | Results obtained |
|                             | Investment                                              | 2        | 3      | 30                                     |                                               |                  |
|                             | Collaboration with universities and/or research centres | 1        | 4      | 40                                     |                                               |                  |
|                             | Activities with schoolchildren                          | 4        | 1      | 10                                     |                                               |                  |
|                             |                                                         |          |        | Degree of development of the dimension |                                               |                  |
| Sustainable infrastructures | Jobs generated in the port                              | 3        | 2      | 20                                     | Values to be determined by the Port Authority | Results obtained |
|                             | Investment                                              | 2        | 3      | 30                                     |                                               |                  |
|                             | Degree of electrification with renewables energies      | 1        | 4      | 40                                     |                                               |                  |
|                             | Sustainable activities                                  | 4        | 1      | 10                                     |                                               |                  |
|                             |                                                         |          |        | Degree of development of the dimension |                                               |                  |
| Gastronomy and tradition    | Jobs generated in the port                              | 1        | 4      | 40                                     | Values to be determined by the Port Authority | Results obtained |
|                             | Investment                                              | 3        | 2      | 20                                     |                                               |                  |
|                             | Existence of a maritime museum                          | 4        | 1      | 10                                     |                                               |                  |
|                             | Traditional activities                                  | 2        | 3      | 30                                     |                                               |                  |
|                             |                                                         |          |        | Degree of development of the dimension |                                               |                  |

## 5. Conclusions

First of all, it should be noted that the methodology applied, based on a Delphi panel, has made it possible to determine the degree of implementation and development of the Blue Economy in the case of Spanish ports, both in relation to the different sectors considered and globally. The degree of development obtained is in base 10, with the values closest to 0 being the lowest degree of development and the values close to 10 being the highest.

It is also concluded that the Blue Economy has become the new economic development model being followed by almost all Spanish Port Authorities, such as Barcelona, Vigo, Motril or Castellón.

On the other hand, most of the dimensions or sectors selected are new in the port world, as four of the seven belong to the group called emerging sectors by the European Union. These four dimensions are:

- Biotechnology
- Research and education
- Sustainable infrastructures
- Gastronomy and tradition

These sectors are mainly linked to research and the promotion of activities such as digitalisation, collaboration with educational centres, biotechnology research, carrying out traditional activities, etc. These dimensions usually require less investment and space for their development and are ideal for the scale of Spanish regional ports, as opposed to other



larger sectors such as the maritime transport of goods, extraction of fossil resources or the construction and repair of ships.

It should be noted that these dimensions are not invariable, the Blue Economy and more so in the emerging sectors, are experiencing a very accelerated development in recent years. The geographical position of the study area clearly influences the choice of dimensions and consequently also the choice of indicators to measure them.

This tool will need to be optimised in the future. As indicator data are collected in different ports, the weighting of these data in their adjustment to a scale of 1 to 10 can be more accurately calibrated. The order of magnitude of some indicators such as the amount of investment in the sectors or the power consumed from renewable energy sources should be improved.

All the sectors analysed make a considerable contribution to combating climate change and improving sustainability in all its dimensions.

Finally, it is important to note that this tool, when data are obtained from several ports, could also be used to make a comparative analysis between them. Knowing the degree of development of a given port in comparison with other neighbouring ports will make it possible to understand its strengths and weaknesses and to plan a future development strategy. This comparison will also have to be gauged by another factor which will allow the ports to be evaluated against each other in terms of their importance, for example the number of traffic handled by the port per year. This can be continued in a future extension of the research carried out.

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