Journal of
Marine Science and Engineering

MDPI

Article

Evaluation of the Implementation of the Dimensions of the Blue Economy in Spanish Ports

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Abstract: The Blue Economy is a relatively new concept. In 2010, Günter Pauli coined this term to refer to an economic development where a waste is raw material for a process, using the cycles of the natural world as an example. Currently, the Blue Economy is a much more broad and transversal concept and is strongly related to maritime economic sectors, from maritime transport to off-shore renewable energies through port operations. In short, the Blue Economy encompasses classic sectors such as shipbuilding together with more innovative concepts in the ports, such as digitalization, innovation, or energy transition. In this research, a new tool is developed which, as its main objective, can obtain a degree of implementation of the dimensions of the Blue Economy in Spanish ports through the evaluation of each of the economic sectors that constitute the B.E. in the 28 Spanish port authorities. To this end, a Delphi panel has been used to determine the importance of each economic dimension, a database has also been generated to determine the state of development of these dimensions in each port, and some equations have been developed to determine in base 100 how developed each port is. The results obtained show a notable development in the average of Spanish ports, highlighting Las Palmas as the port that has most developed the Blue Economy.

Keywords: B.E.; grade development tool; Spanish ports

Citation: Vaca Cabrero, J.; Gómez Garach, C.P.; Camarero Orive, A.; González-Cancelas, N. Evaluation of the Implementation of the Dimensions of the Blue Economy in Spanish Ports. *J. Mar. Sci. Eng.* **2024**, *12*, 222. https://doi.org/10.3390/jmse12020222

Academic Editor: Mihalis Golias

Received: 8 January 2024
Revised: 22 January 2024
Accepted: 23 January 2024
Published: 26 January 2024

1. Introduction

The origin of the Blue Economy (B.E.) is based on the generation of wealth and economic growth, promoting the regeneration and preservation of ecosystems, through the use of the resources provided by the marine environment. This new economic model seeks to mimic the functioning of the natural ecosystem. It aims to implement the principle of the circular economy that seeks to convert waste into newly usable resources, something that allows the marine ecosystem to be considered a source of innovation and growth for profitable and sustainable development [1].

Today, when experts talk about the B.E., they do so from a more transversal perspective, closely related to the maritime economic sector [2].

The B.E. represents a paradigm shift in economic thinking, where the sustainable use of ocean resources and services takes center stage, recognizing the importance of marine resources and ecosystem services in driving their development, while emphasizing the need for responsible resource management and environmental conservation [3]. It encompasses a variety of sectors, including fisheries, aquaculture, renewable energy, coastal tourism, marine biotechnology, and shipping, among others. By taking a holistic approach to resource management, the B.E., in the context of port development, seeks to strike a balance between economic growth, social well-being, and environmental sustainability [4]. According to the European Union, the development of this economic model is closely linked to the concept of Blue Growth Initiative: a long-term initiative to support the sustainable development of the marine and maritime sectors [5].

As can be seen, the concept of the B.E. is relatively recent compared to other traditional economic approaches. Although the oceans have always been a source of resources and

economic activity, the term "B.E." and its specific focus began to gain prominence from the 2010s onwards, highlighted by a report of the European Parliament [6], a key milestone that drove the popularization of the term. Since then, the concept of the B.E. has been adopted and scaled up by various international organizations, national governments, academic institutions, and interest groups [7]. It has become a strategic approach to address sustainability challenges in relation to oceans and related economic activities.

At present, there is almost no research or methods that allow the establishment of specific criteria to assess the level of development or progress of this B.E. model, with even more research directly related to port activity.

Thus, the core of this research is to create a model for evaluating the degree of implementation of the different sectors of the B.E. in Spanish ports through different tools, such as the creation of a database to collect the different projects carried out by the 28 Spanish port authorities. We used a Delphi panel to assess the degree of importance of each economic sector involved and create a method to achieve the B.E. in each port authority.

2. State of the Art

The B.E. has emerged as a key concept in the field of sustainability and economic development. In the definition and presentation of this term, it is essential to talk about the Belgian economist Gunter Pauli. According to Pauli, this economic model seeks to enhance sustainability, guaranteeing the improvement of the system and promoting the emergence of new possibilities that allow future generations to have, at least, the resources that the current generation has today. It turns scarcity into abundance, and poverty into development, by working with what you have, being creative, and encouraging entrepreneurs to make this possible. These are some of the principles that lay the foundations of the B.E., where it is worth highlighting the discrepancy between those who founded the aforementioned economy and the principles of the linear economy [1].

Over the years, the concept of the B.E. has evolved and expanded across different sectors and regions.

The evolution of the concept of the B.E. has been a gradual process that has gained momentum in recent decades by linking with the marine and maritime economic sectors. Initially, it focused on traditional economic activities such as fishing, coastal tourism, and boating. However, with the growing recognition of the importance of marine resources and the need for their sustainable management, the concept has expanded to include other sectors, such as marine renewable energy, marine biotechnology, sustainable aquaculture, shipping, port activities, and the responsible exploration and exploitation of marine mineral and energy resources [7,8]. In addition, the B.E. approach has been expanded to cover aspects such as maritime governance, maritime security, and integrated coastal zone management [9]. Numerous institutions have given significant importance to this economic model, and in recent years this term has become popular among different administrations and organizations, including various governments and institutions such as the EU, the United Nations, FAO, etc. [10].

In the European context, the European Union (EU) annually issues a report entitled the Blue Economy Report [8] 2021 as a sign that the B.E. has become a priority on the policy agenda. The European Commission has identified 14 main sectors of the B.E., which are divided into two main groups: established sectors and emerging sectors.

The established sectors are those that already have a relevant track record as well as a more advanced degree of development than others, being contributors to the evolution of the B.E. within the European Union. A total of seven are distinguished, which in turn are divided into different subsectors (Figure 1).

Figure 1. Established sectors of the B.E. Source: Own elaboration based on the Blue Economy Report of the European Union.

Emerging sectors are defined as those sectors that are novel in the field of the B.E., referring to those activities that are directly linked to the marine environment whose environment has not reached a certain degree of maturity or where data are not available in the public domain (Figure 2).

Figure 2. Emerging sectors of the B.E. Source: Own elaboration based on the Blue Economy Report of the European Union.

These sectors, both established and emerging, have significant potential to generate jobs, economic growth, and sustainable development in Europe's coastal regions. The EU has developed specific strategies and policies to foster the growth of these sectors, such as the Sustainable B.E. Action Plan and the Marine Strategy Framework Directive [11].

Linking the B.E. to the Sustainable Development Goals is critical to understanding its importance in the global context. SDGs 14 (Life Below Water) and 15 (Life on Land) are directly related to the conservation and sustainable use of marine and terrestrial resources, respectively. These goals seek to protect marine and terrestrial biodiversity, promote sustainable fisheries, reduce marine pollution, and conserve coastal and marine ecosystems [12].

In addition, the B.E. can also contribute to other SDGs, such as SDG 16 (Peace, Justice and Strong Institutions) and SDG 17 (Partnerships for the Goals). In the case of SDG 16, the B.E. can foster effective maritime governance, the fight against illegal and unregulated fishing, and promote peace and security in the oceans. On the other hand, SDG 17 highlights the importance of partnerships and global cooperation to achieve the Sustainable Development Goals, and the B.E. can facilitate collaboration between different actors, including governments, international organizations, the private sector, and civil society [12].

It is well known that the B.E. requires financing for its implementation, development, and flowering. It needs the help of partnerships along with public–private partnerships. However, it is true that a conditioning factor is the degree of economic development of each country. Sectors that are deeply linked to the port sector, such as fishing or aquaculture, and with an important weight in the B.E., require reforms and stimuli that promote their growth or renewal. Fiscal policy is used in these types of cases to encourage sustainable development by encompassing the environment, economy, and social collectives [13]. One of the main investors in this area of the economy is the World Bank, which has invested more than USD 9 billion in active projects since 2021. It is worth highlighting programs, such as "Problue", created in 2018, which is a trust fund composed of numerous donors that supports the development of the marine environment and the resources that are intrinsically linked to it [14]. Financial instruments such as bonds are also used with the aim of promoting new models of sustainable financing. Green and blue bonds are debt issues that aim to finance projects focused on conserving and protecting the environment and the marine environment, respectively. FAO (2020) [15].

Ports have a fundamental position in this economy through the different sectors [16]. There is a growing interest in taking advantage of the resources and opportunities offered by port areas. Ports are not only key infrastructures for international trade, but they can also become hubs for innovation and the development of sustainable technologies. For example, measures are being implemented to reduce marine pollution in ports, such as the electrification of cargo handling equipment and the use of cleaner fuels. In addition, new ways of harnessing ocean energy and marine mineral resources in ports are being explored, thus promoting the transition to a more sustainable B.E. [17].

Regarding the development of the B.E. in Spain, there are several reports and studies that highlight its importance and potential. According to a report by the Cotec Foundation, Spain has a large industrial and technological base related to the marine environment, which gives it an advantageous position. The report also highlights the need to boost research, development, and innovation in this area, as well as to promote collaboration between the public and private sectors.

Another relevant report is the Spanish sustainable development strategy [18] prepared by the Ministerio de Transición Ecológica. This plan establishes a roadmap to promote the sustainable growth of the B.E. in the country, addressing aspects such as the protection of the marine environment, the promotion of sustainable fisheries, the promotion of aquaculture, the improvement of maritime governance, and the creation of employment in related sectors.

Port authorities in Spain are no strangers to the transformation that the development of the B.E. entails, as there are experiences that corroborate it:

The Port of Vigo has been developing the "Blue Growth" strategy for a few years, which aims to make this port an inclusive, innovative, connected, and green port, with the deadline for achieving it being 2027 [19]. The Port of Barcelona has great involvement with the B.E. and is involved in "Blue-Up", a program which has been designed through a public–private collaboration, which encourages the participation of sustainable and blue

start-ups in order to promote the progress and development of their initiatives more quickly. The port of Castellón promotes projects linked to blue energy, and emerging sectors such as the repair, construction, maintenance, or remodeling of ships [20].

On the other hand, P. Bond [21] provides a critical assessment of the implementation of the B.E. in South Africa, highlighting the threats, contradictions, and resistances that arise in the process, and offers a perspective from the field of political ecology.

P. Choudhary et al. [22] examine the potential of the B.E. as a way to empower undervalued marine ecosystems and turn them into a sustainable industry that promotes economic development and the conservation of marine resources. It provides a perspective on how the B.E. can contribute positively to the management of marine ecosystems and the creation of a sustainable industry.

In a study prepared by R. M. Martínez-Vázquez et al. [23], the authors provide a quantitative assessment of the impact of B.E. sectors using a variety of statistical approaches. The results could help to better understand how these economic activities influence various aspects, which could be valuable for decision making and policy planning related to the B.E. and the sustainable management of marine resources.

E. Tijan et al. [24] examine how the adoption of digital technologies in the shipping sector can be an effective means of achieving the objectives of the B.E. by improving sustainability, efficiency, and economic growth in the maritime domain.

Another international example is the case of Montenegro and its maritime transport within the framework of the B.E. [25]. It provides a detailed analysis of the measures and strategies implemented in Montenegro to promote more sustainable shipping practices and their impact in the context of the B.E.

The B.E. is an evolving concept. It is closely linked to concepts such as digitalization, energy transition, and Blue Ocean.

There are both established and emerging sectors (maritime transport, port activities, research and innovation, blue biotechnology, etc.) that are currently experiencing a digital revolution. New technologies such as Artificial Intelligence, Digital Twins, and the Blockchain are assisting the decision making of the different agents involved in infrastructure, facilitating the visualization of information, real-time collaboration, capacity management and planning, etc. [26,27].

Spanish ports are implementing these new technologies to promote sustainability, environmental quality, and logistical efficiency. This digital transformation is known as Ports 4.0 or Smart Ports, and encompasses aspects such as automation, digitization, interoperability, and improving the customer experience. The Blue Ocean concept aims to achieve effective digitalization that will lead the Spanish port system towards Port 4.0 [28].

Other sectors, such as marine renewable energy or ocean energy, are key focuses in ports to achieve the energy transition. Ports are energy hubs through which most of the energy materials used by coastal countries are imported and exported [29]. Mills for offshore wind farms are also installed and distributed in port facilities, and plants are built to produce green hydrogen, ammonia, etc. Key products to achieve the decarbonization targets that are being demanded by some national and supranational organizations [30].

This energy transition is not only taking place in the economic sectors associated with ports. The concept of a "green port" is becoming more and more widespread and refers to a port that has actively committed to adopting sustainable practices and policies to minimize its environmental impact and promote social responsibility. These ports seek to integrate environmental considerations into their infrastructure and operations, focusing on energy efficiency, emission reduction, waste management, and the promotion of environmentally friendly practices [31].

3. Materials and Methods

3.1. Objective

As we have seen in the previous section (the state of the art), the B.E. is a innovative term that has not yet seen fully established development of its activity in all the areas it

affects. In addition, this term, when applied in the port area, has little experience, i.e., the information is not abundant due to the fact that the activities related to it are relatively recent and currently in full implementation and development. There is not a large amount of research on the B.E. applied to ports, nor methods that allow the establishment of specific criteria to measure and/or evaluate the level of development or progress of this economic model.

That is why the core of this paper is to determine the current degree of implementation of the B.E. in Spanish ports.

3.2. Method

A methodology has been developed (Figure 3) that is based on the following fundamental points:

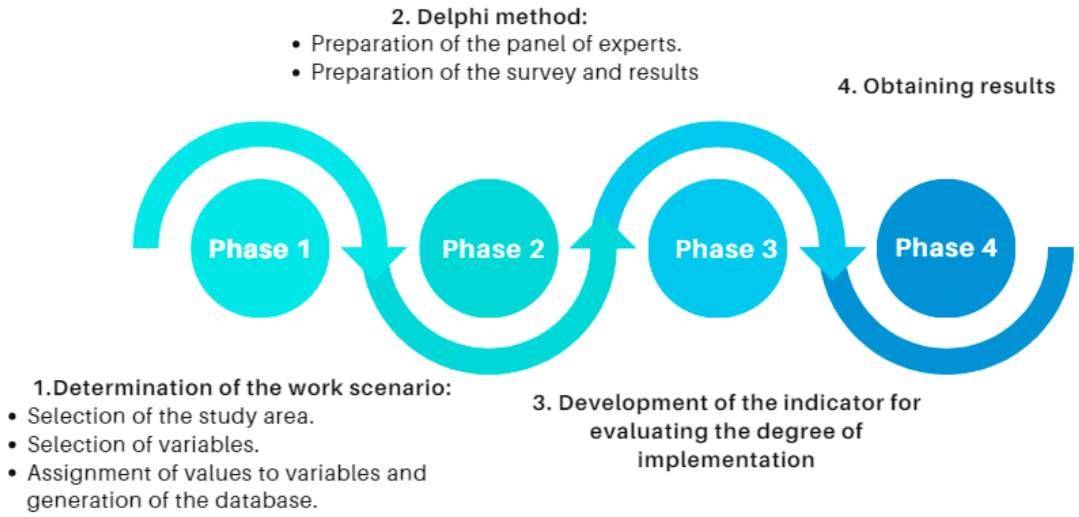

Figure 3. Phases of the research. Source: own source.

Phase 1. Determination of the work scenario:

- **Selection of the study area**

It was decided to study the 28 port authorities that make up the Spanish Port System. This is due to the fact that Spain is the country in the European Union with the most kilometers of coastline and it has access to the two main maritime facades of the European continent: the Atlantic and the Mediterranean. In addition, the Iberian Peninsula has a very important strategic importance because to the south of it is the Strait of Gibraltar, a choke point of international maritime transport routes.

That is why all state-owned ports were considered, as this allowed a representative sample to be obtained.

Below is a map showing the distribution of the locations of the port authorities studied (Figure 4).

- **Selection ofvariables to be studied**

According to the literature review carried out in Section 2: State of the Art, 7 sectors belong to the group of established sectors and 6 to the group of emerging ones. Each of them has a direct or indirect link with port activities. Table 1 shows each sector with a short description.

Figure 4. Port authorities of Spain. Source: Puertos del Estado.

Table 1. Classification and description of the sectors of the B.E. Source: own source.

Group	Sector	Description
Established	Living marine resources	Encompasses both the collection of those biological resources with the capacity to degrade and renew themselves (primary sector), as well as their processing (conversion into food, feed, bioproducts, and bioenergy) and distribution throughout the supply chain.
	Inert marine resources	Exploitation of energy sources and raw materials from the ocean.
	Marine renewable energy	Off-shore wind. Europe is the world leader with 90% of the installed capacity. This sector has experienced exponential growth since 2009 in all indicators; the countries located in northern Europe are the most developed in this sector.
	Port activities	This sector is divided into two main subgroups: loading and storage of goods, and maritime and port projects, including construction of facilities and service of transport-related activities.
	Shipbuilding and repair	The shipyard industry is a dynamic and competitive sector that Europe leads worldwide.
	Maritime transportation	Composed of the following subsectors: passenger transport, freight transport, and transport services.
	Coastal tourism	Largest sector in terms of GDP and jobs. Tourists in the coastal areas of southern European member countries are more numerous; tourism is particularly important in countries such as Spain, Portugal, Italy, Malta, and Greece.
Emerging	Ocean Energy	Composed of renewable energies such as off-shore floating wind, tidal, floating photovoltaic, and off-shore H2 generation.
	Blue Biotechnology	This sector aims to promote the use of biomass for industrial applications.
	Desalination	This sector will play a major role in the economic development of the continent as many regions of the Mediterranean area will face serious problems related to freshwater supply by 2050. The most common technologies in desalination are reverse osmosis, electrodialysis, nanofiltration, and distillation by multi-effect evaporation.
	Defense, Security, and Surveillance	A sector of large investments by coastal member countries. In recent years, the European Maritime Security Strategy has been launched, which seeks to protect the citizens and interests of the Union.
	Research and Education	Some potential actions are: • Knowledge on the impacts of climate change on marine ecosystems. • Preserving coastal ecosystems. • Reducing investment risk. • Development of smart ports.
	Infrastructure	There are initiatives in ports to reduce emissions during construction and facilitate the colonization of structures. The development of submarine cable networks is also being implemented to improve telecommunications.

- **Assigning values to variables and developing the database**

This phase includes a detailed analysis of all the activities related to the sectors of the B.E. that are being developed in each of the 28 Spanish port authorities.

The development of the database comprises two main divisions, the first for established economic sectors and the second for emerging economic sectors. The evaluation criterion used consists of assigning points based on the degree of development or implementation of an economic sector in the port authority studied. A maximum score of 3 was established for those institutions that promote or have implemented the economic activity in question. A value of 2 was assigned to those institutions that are studying the implementation of the aforementioned activity, and finally a score of 1 was given to those that are not adopting measures to implement said activity.

Phase 2. Elaboration of the Delphi panel of experts

In this fourth phase, the aim was to establish the degree of importance of each economic sector studied, for which the Delphi method was used.

This method makes it possible to draw up a ranking of importance, and it is also in line with the present level of research, since it is a novel study and there are not too many references on the subject [32].

The Delphi method involves dialogue and feedback from experts [33].

The selection of experts from the field of application for the Delphi panel is based on the need to encompass a diversity of perspectives and experiences, thus ensuring a comprehensive representation of knowledge in the area. This large group of experts seeks to reduce individual biases, validate findings, and deepen the exploration of ideas, enriching the panel with a variety of voices and insights. Meaningful expert involvement not only enhances the credibility of the study, but also makes it easier to identify key relationships and gain consensus around the importance of relevant factors in the field of application.

The surveys were carried out electronically using the Microsoft Forms platform; this application can easily send out surveys, collect and analyze the responses, and export the data in different formats compatible with different programs to analyze them.

In the selection of experts for the generation of the affinity matrix, rigorous criteria were applied based on professional experience, thematic specialization, diverse representation, previous achievements and contributions, collaborative skills, interdisciplinarity, availability, and commitment, as well as recognition in the scientific community. These criteria ensure the equitable and meaningful participation of experts with diverse perspectives and expertise in the field, thereby strengthening the validity and breadth of the analysis in the study. Among the experts were researchers of recognized prestige in the field of port management and operation in Spain, professionals from private companies linked to the economic sectors evaluated such as freight transport companies, handling and storage, etc. Finally, professionals who had several years of experience working in one of the port authorities were also included.

The questionnaire was answered by 24 experts and consisted of the following questions in which the following results were obtained:

First, the importance of the different established economic sectors that make up the B.E. was ranked (Figure 5).

The second question consisted of ordering the different emerging economic sectors that make up the B.E. from the most to least important (Figure 6).

The third question asked the respondent to establish, on a scale of 1 to 10 according to their own criteria, the degree of importance that the activities already established have globally (Figure 7).

In this way, the importance attributed by the group of experts to the different sectors was considered using rounding in order to facilitate calculations, adopting a 60% weight for established activities and, likewise, 40% weight for emerging activities.

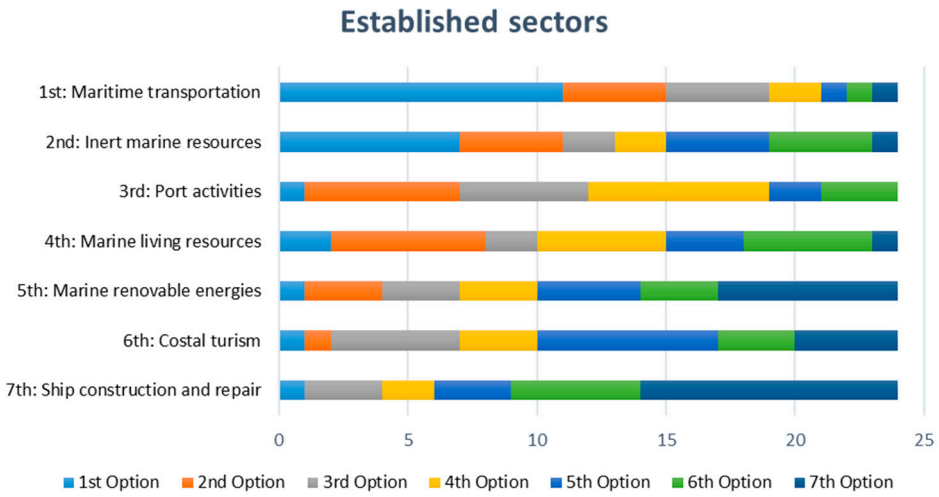

Figure 5. Degree of importance of established sectors. Source: own source.

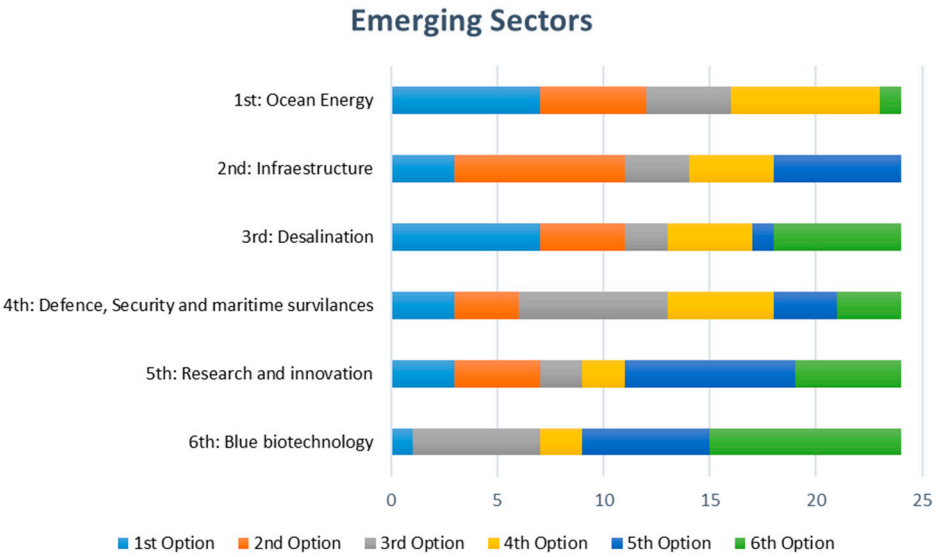

Figure 6. Degree of importance of emerging sectors. Source: own source.

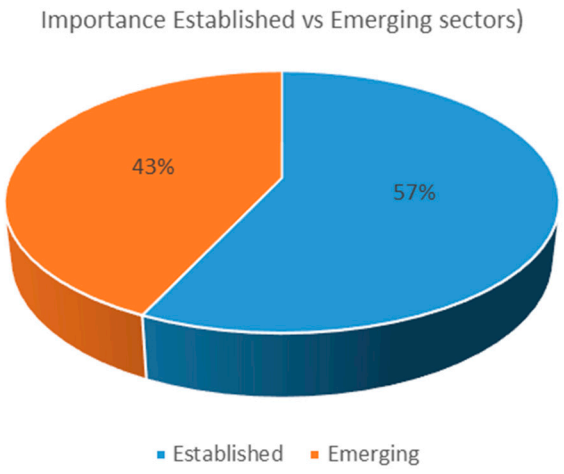

Figure 7. Degree of importance of established vs. emerging sectors. Source: own source.

Phase 3. Development of the Implementation Assessment Indicator

In this phase of the research, an indicator was developed to assess the B.E. implementation both by economic sectors and by port authorities.

From the importance rankings obtained from the survey with the Delphi panels of experts, a score is given to each of the sectors evaluated based on the position obtained in the survey.

Table 2 shows the score obtained for each sector.

Table 2. Classification of economic sectors. Source: own source.

Established Sectors	Punctuation	Emerging Sectors	Punctuation
1st: Maritime transportation	7	1st: Ocean Energy	6
2nd: Inert marine resources	6	2nd: Infraestructure	5
3rd: Port activities	5	3rd: Desalination	4
4th: Marine living resources	4	4th: Defence, Security and maritime survilances	3
5th: Marine renovable energies	3	5th: Research and innovation	2
6th: Costal turism	2	6th: Blue biotechnology	1
7th: Ship construction and repair	1		

This scale, together with the data obtained in Phase 2, was used to develop the mathematical expression that evaluates the degree of development of the B.E.:

Established sectors:

$$R_{ES} = \sum_{i=1}^{m} (\alpha_i \times \beta_i) \times \frac{100}{84}$$

where:

- R_{ES}: Degree of development of the sectors established for each port authority.
- α_i: State of development of the economic sector established in the port authority.
- β_i: Score according to the importance of the sector obtained using the Delphi method.
- m: Each of the seven established sectors of the B.E.
- 100/84: Obtaining results on a base of 100.

Emerging sectors:

$$R_{EM} = \sum_{j=1}^{n} (\alpha_j \times \beta_j) \times \frac{100}{63}$$

where:

- R_{EM}: Degree of development of emerging sectors for each Port Authority.
- α_j: State of development of the emerging economic sector in the Port Authority.
- β_j: Score according to the importance of the sector obtained using the Delphi method.
- n: Each of the six emerging sectors of the B.E.
- 100/63: Obtaining results on a base of 100.

The results of the development of the B.E. in each port were obtained by this expression:

$$R_{global} = \left\{ 0.6 \times \left[\sum_{i=1}^{m} (\alpha_i \times \beta_i) \right] + 0.4 \times \left[\sum_{j=1}^{n} (\alpha_j \times \beta_j) \right] \right\} \times \frac{100}{147}$$

The weight was 0.6 for established activities and 0.4 for emerging activities.

Phase 4. Obtaining results

The results obtained are shown in Table 3. This shows, for each port authority, the degree of implementation of both the established and emerging sectors and their overall result, all based on 100. The last column shows the percentage points of deviation of each port authority from the average of the overall results.

Table 3. Degree of implementation of the B.E. in Spanish ports. Source: own source.

Port Authorities	Established Sectors	Emerging Sectors	Global Results	Deviation From the Mean
LAS PALMAS	100	100	100%	21%
BAHÍA DE ALGECIRAS	93	92	93%	13%
HUELVA	93	89	91%	12%
CARTAGENA	90	89	90%	10%
FERROL-SAN CIPRIÁN	90	87	89%	10%
MÁLAGA	90	87	89%	10%
SANTA CRUZ DE TENERIFE	86	87	86%	7%
CEUTA	81	87	83%	4%
A CORUÑA	80	86	82%	3%
ALMERÍA	80	84	82%	2%
BARCELONA	80	84	82%	2%
PASAJES	79	84	81%	1%
VIGO	79	83	80%	1%
ALICANTE	76	79	77%	−2%
AVILÉS	76	79	77%	−2%
BAHÍA DE CÁDIZ	76	78	77%	−3%
BALEARES	76	78	77%	−3%
BILBAO	76	78	77%	−3%
CASTELLÓN	76	78	77%	−3%
MELILLA	76	75	76%	−4%
MOTRIL	76	75	76%	−4%
SANTANDER	76	68	73%	−6%
TARRAGONA	76	65	72%	−8%
VALENCIA	76	65	72%	−8%
MARÍN Y RÍA DE PONTEVEDRA	71	65	69%	−11%
GIJÓN	67	65	66%	−13%
SEVILLA	67	65	66%	−13%
VILLAGARCÍA DE AROSA	67	65	66%	−13%

Figures 8–10 graphically show the position of each port authority, ordered from the highest to lowest degree of implementation, and its deviation from the average when analyzing the degree of total implementation by established sectors and by emerging sectors, respectively.

Figures 11 and 12 analyze the data by economic sectors instead of authorities, thus obtaining the degree of development or implementation of both the seven established sectors and the six emerging ones.

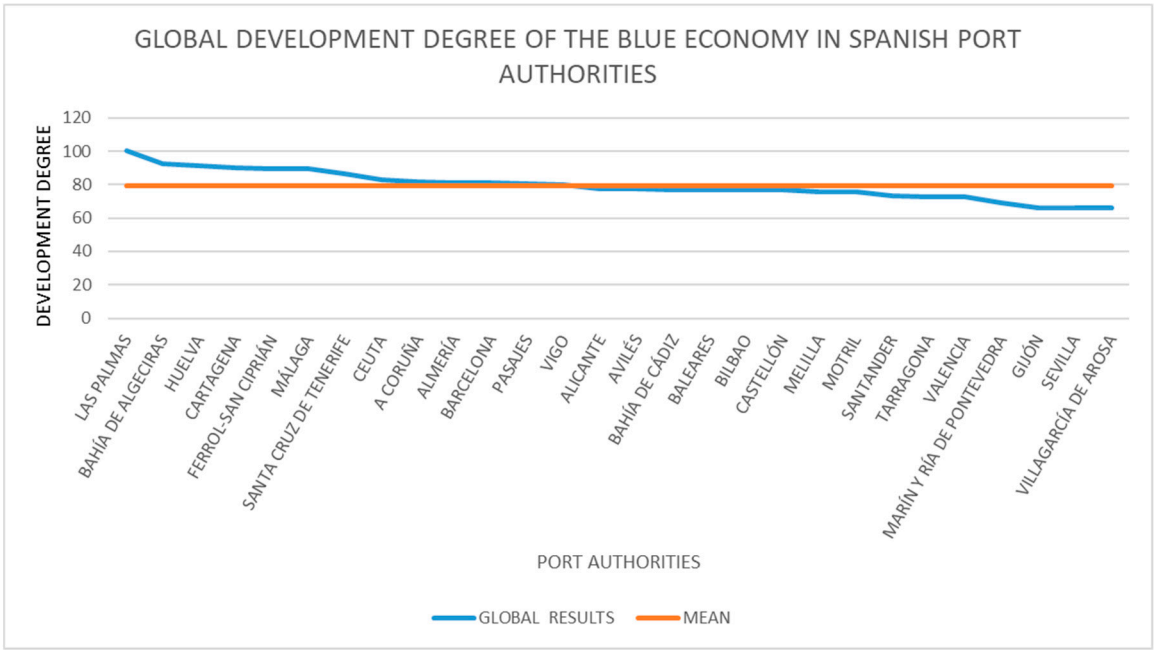

Figure 8. Classification of port authorities by degree of global development of the B.E. Source: own source.

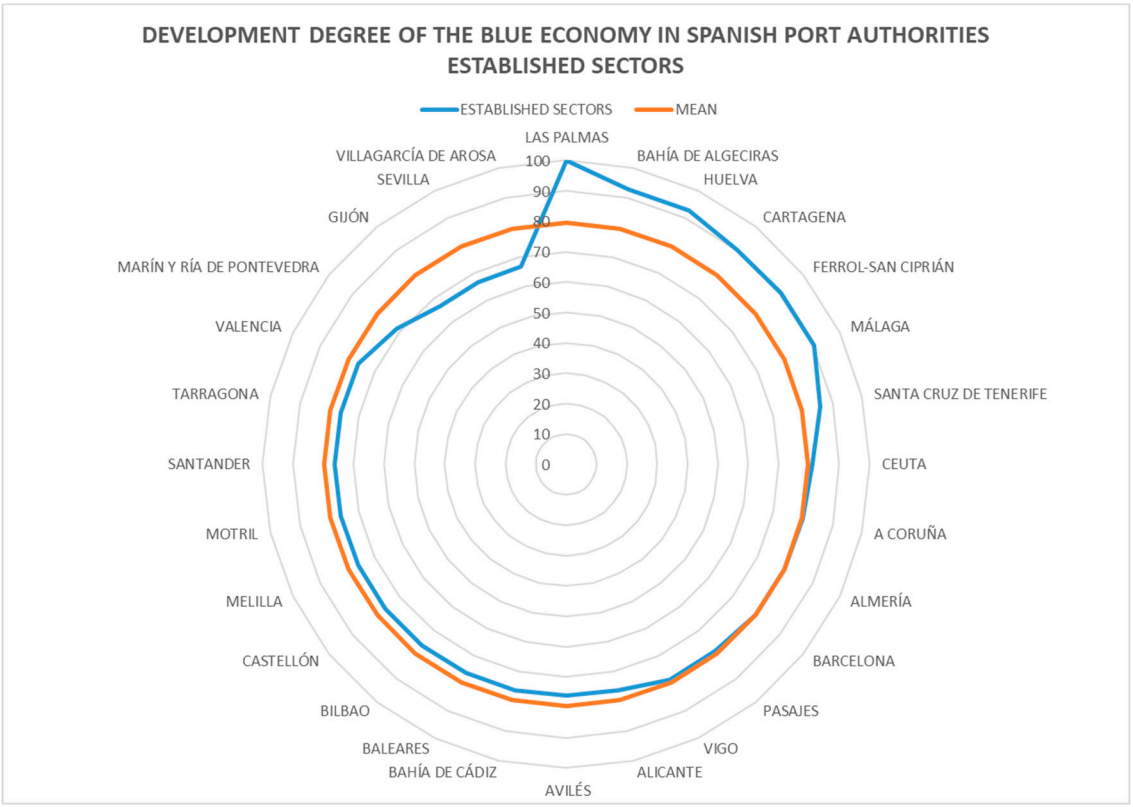

Figure 9. Classification of port authorities by degree of development of the established sectors. Source: own source.

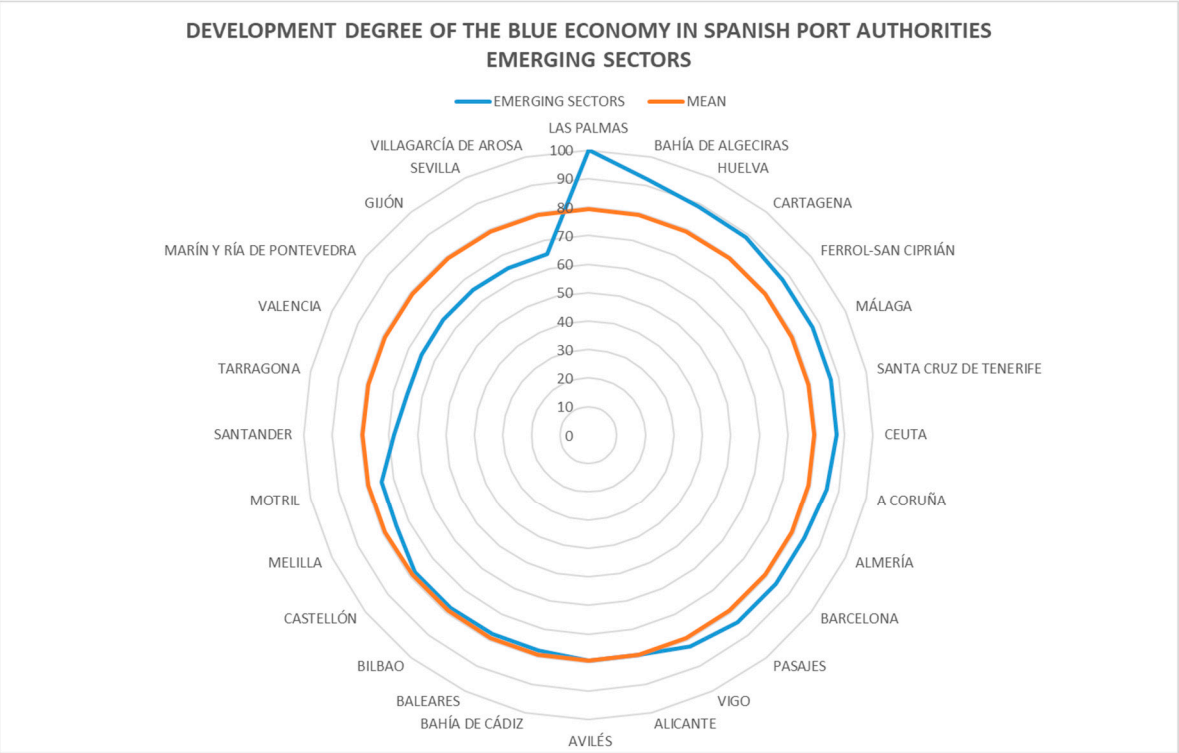

Figure 10. Classification of port authorities by degree of development of emerging sectors. Source: own source.

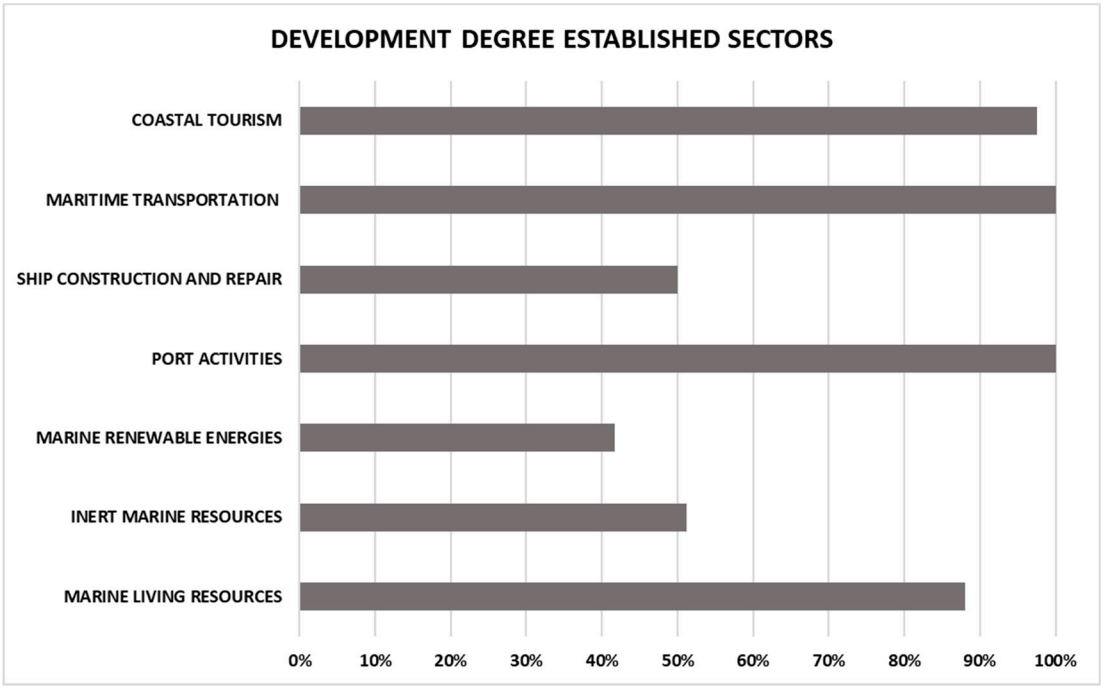

Figure 11. Degree of development of the sectors established in the Spanish port system as a whole. Source: own source.

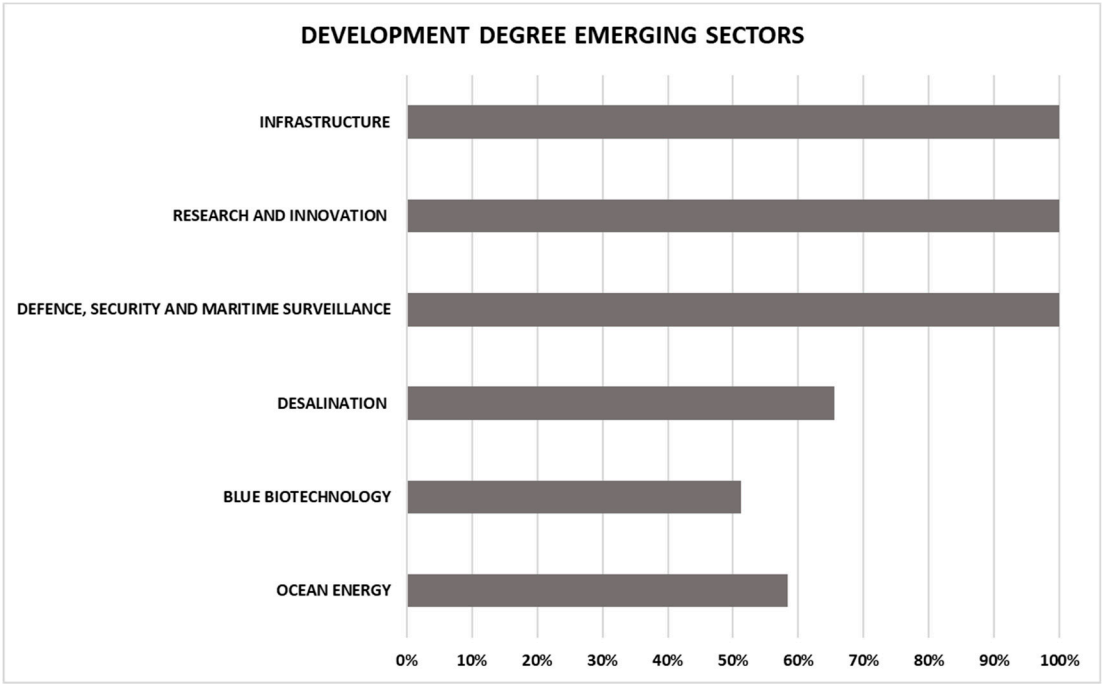

Figure 12. Degree of development of emerging sectors in the Spanish port system as a whole. Source: own source.

4. Analysis of Results

An analysis of the global data on the implementation of the B.E. in Spanish ports (Table 3 and Figures 8–10) shows that this implementation has an average of 78% throughout the system. Above this average are 13 of the 28 port authorities, with Las Palmas standing out in first place due to its development of projects related to each of the 13 sectors evaluated. This port obtained the highest score in the evaluation of both established and emerging sectors. These records are justified by the fact that Las Palmas is an island port, located in the Canary Islands. It has a strategic position in the Atlantic for north–south connections, and it enjoys high strategic differentiation as it is currently developing projects in each of the dimensions evaluated, from the promotion of tourism to the development of offshore renewable energy, through the construction and repair of ships. In addition, its port authority is actively promoting high economic dynamism.

The port that lagged behind the most in the implementation of this type of project was Villagarcía de Arosa, which was, on average, 13 points below the national average.

Other organizations such as Bahía de Algeciras, Huelva, or Cartagena obtained results above 90%, a very relevant figure when it comes to Bahía de Algeciras as the main Spanish port by volume of traffic. These ports show excellent results despite being in different geographical areas and being of different sizes. The key to these ports is their differentiation in the development of projects, as with their strategic plans they are trying to develop actions in most dimensions.

It was observed that for both established and emerging sectors (Figures 9 and 10) there were large differences between port authorities. Ports such as Villagarcía de Arosa, Gijón, and Seville were more than 30 points behind Las Palmas and 13 points below the national average.

A noteworthy case is that of the port of Valencia. This port is the leader of the Spanish port system in terms of container traffic, so its importance for the system is notorious, but on the other hand, when evaluating the degree of implementation of both established and emerging sectors, it ranked 24th out of 28 in both cases. This is a far cry from the national average and from the top positions that a port of such importance is supposed to occupy.

To conclude this analysis of results, it should be noted that if the degree of development of the economic sectors established in Spain as a whole is measured, coastal tourism, port activities, and maritime transport clearly stand out, all of them above 95% development (Figure 11); however, the marine renewable energy sector barely exceeds 40%. Thus, a very uneven development between sectors can clearly be observed. If the emerging sectors are analyzed (Figure 12), it can be seen that practically all port authorities are developing projects related to the economic sectors of infrastructure, research, and security; the sector that is in the lowest position among the emerging sectors in terms of the degree of implementation is blue biotechnology, at just over 50%.

5. Conclusions

First of all, the main objective of this article has been met: to create a model for evaluating the degree of implementation of the different sectors of the B.E. in Spanish ports. It is concluded that all port authorities actively promote the development of the B.E., since the average degree of development of all the sectors involved in the B.E. is 80% in the Spanish port system as a whole.

Undoubtedly, it can be said that the priority given to the exercise of the established dimension in comparison with the emerging dimension is justified. This preference may be due both to the greater importance of the activities involved and to the more advanced level of technological development that it currently presents. In addition, the activities of established sectors are associated with a lower economic risk for investors (they are activities that have already been tested and developed in different places and under different conditions).

It should be noted that the ratings obtained with this model are inherently variable, as they are subject to different economic, social, and political dynamics in addition to the technological development that does not stop occurring. For all these reasons, it is important to study the economic activity in each port with some regularity, since its evaluation may change.

In addition, the categorization of each dimension or economic sector into one of the two groups (established or emerging) is also subject to variation since, with the advances generated in the coming years, those activities with less development may experience exponential growth that places them above those already established, thus altering the classification established in the analysis.

On the other hand, this study highlights that 13 of the 28 Spanish port authorities exhibit a level of overall B.E. development that exceeds the general average. This is due to the boost in the activities of established sectors that have a higher degree of development than emerging ones. For this reason, it is considered necessary to promote the emerging economic sectors as they have greater capacity for growth.

Also noteworthy is the difference of more than 30 points that exists between different port authorities; for example, the Port of Las Palmas obtained 100%, the maximum rating, but Villagarcía de Arosa obtained 66%, a 34% difference. This is a great inequality in the Spanish port system. As a proposal to reverse this situation, it is recommended to use this degree of development as a factor to be taken into account in the annual economic distribution of the Interport Compensation Fund, a mechanism of solidarity between the Spanish port authorities.

To conclude, this tool for comparing port authorities is a valuable method for analyzing the barriers and potentialities of Spanish ports in the development of the B.E., providing a more comprehensive view of each port in question, allowing their strengths to be promoted, as well as addressing and improving their weaknesses. It can be a tool used to carry out comparative analyses between the entities that manage Spanish ports, or with another differentiated objective: to promote the exercise of certain activities that allow a strategy to promote the growth and development of different points of the coast, individually or through the coalition of several port authorities, which are known as maritime facades.

As an example, it is proposed that the potential of the strengths of the Mediterranean coast will make Spanish ports strong in the promotion of coastal tourism or desalination, while the union of the Atlantic façade can promote activities such as maritime transport or maritime renewable energy or the creation of hubs in ports to carry out the so-called energy transition.

This study, which focuses on promoting a coalition or establishing a differentiation between ports, could serve as a basis for future analyses in which the implications of the research developed in this work are further explored, providing a solid basis for strategic decision making and the implementation of policies that promote the development of the B.E. in Spanish ports.

The assessment of differences of 1% or 10% in terms of the implementation of the Blue Economy in Spanish ports could be approached from various perspectives, among which cost analysis could be a key consideration. For future lines of research, firstly, the economic impact of the implementation of specific projects in each port and sector could be examined. Cost–benefit evaluations could be carried out to determine the efficiency of investments and compare returns between ports with differences of 1% or 10% in the implementation of the Blue Economy.

In addition, a detailed analysis of the financial resources allocated to each port and sector could be carried out, identifying the areas in which ports with higher levels of implementation invest more or less compared to those with lower levels. This could reveal spending patterns and allow for strategic adjustments to optimize resource allocation.

Finally, another way to assess these differences could be by measuring the operational efficiency and productivity of projects at each port. Key performance indicators (KPIs) could be compared across ports to identify successful practices and areas for improvement.

Author Contributions: Conceptualization, J.V.C. and A.C.O.; Methodology, J.V.C., A.C.O. and N.G.-C.; Formal analysis, J.V.C.; Investigation, J.V.C., C.P.G.G., A.C.O. and N.G.-C.; Resources, J.V.C., C.P.G.G. and A.C.O.; Writing—original draft, J.V.C. and A.C.O.; Supervision, A.C.O. and N.G.-C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

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