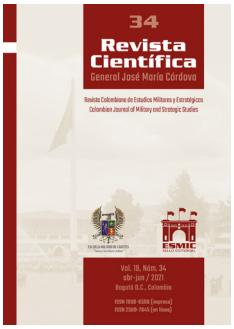

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Proposal for a model to measure nations' maritime power

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Proposal for a model to measure nations' maritime power

Propuesta de un modelo de medición del poder marítimo de las naciones

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Abstract. A nation's maritime power is a crucial factor for its development and security. It also involves various variables that make it a relative and complex concept to compare with other countries in the region and the rest of the world. Therefore, this article proposes a model for measuring maritime power that allows the states' evaluation and comparison. To this end, it begins with basic doctrinal naval concepts to build clear and measurable definitions of maritime power, maritime development, maritime security, and naval power to generate the necessary indicators and indices that support the model's validity and reliability. Finally, it presents the results of its application in a global and regional sample.

Keywords: coastal zone; Law of the Sea; maritime development; maritime power; maritime security; state security

Resumen. El poder marítimo de una nación es un factor crucial para su desarrollo y su seguridad, y al mismo tiempo involucra diversas variables que lo hacen un concepto relativo y complejo de comparar con los demás países de la región y el mundo. Por ello, este artículo busca proponer un modelo de medición del poder marítimo que permita evaluar los Estados, así como hacer comparaciones entre ellos. Para ello se parte de conceptos navales doctrinarios básicos, con el fin de construir definiciones claras y medibles de poder marítimo, desarrollo marítimo, seguridad marítima y poder naval, para generar los indicadores e índices necesarios que sustentan la validez y confiabilidad del modelo. Finalmente se presentan los resultados de su aplicación en una muestra global y regional.

Palabras clave: derecho del mar; desarrollo marítimo; poder marítimo; seguridad del Estado; seguridad marítima; zona costera

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Introduction

This work is the product of a research project on the security of the Mexican State, developed between 2015 and 2020. Its purpose is to develop a new model for measuring nations' maritime power, based on recognizing the importance of the naval dimension in the states' historical evolution, development, and security.

To this end, the article begins with the fundamental conceptual framework. It then presents the methodology developed, proposing a novel measurement model integrating the main variables to be considered from their respective equations. The indexes selected, this article presents the standardized values, each factor represented by the same unit of measurement.

It then presents the qualitative model's operationalization, the testing of the hypothesis, and the results obtained for the nine Latin American countries with significant armed forces. Finally, it states the conclusions drawn from this research and presents the proposed model. In addition, it includes the selected indices and the validity of the conceptual model in two annexes.

Conceptual framework

First of all, it is important to bear in mind that "almost three-quarters of the world is covered by seawater […]. Human life began in the sea and has been dominated by it ever since. It is crucial to our way of life, our very survival as a species" (Till, 2007, p. 29). Acknowledging the previous, the basic definitions on which this research is based must be explained.

Maritime power

Maritime strength or power can be conceived as the sum of a nation-state's naval means and capabilities in terms of ports and naval stations, shipyards, merchant and fishing fleets, nautical and naval training schools, navy, and coast guard. This power, in turn, reflects the interests of the political command in power over the sea (Gorshkov, 1976; Centro de Estudios Superiores Navales [CESNAV], 2003).

For Till, the most renowned contemporary British naval treatise writer, discussing maritime power does not simply involve what is required to use the sea; it is also about the ability to influence other people or things' behavior through what is done on or from the sea. Moreover, it involves the capability available at sea to determine sea and land events (Till, 2007, pp. 26-27).

On the other hand, following Mahan, the main conditions affecting national power at sea are recorded in the following notes that the mentioned naval thinker par excellence identified at the end of the 19th century:

1. Geographical position (insular power amid maritime lines)
2. Physical configuration, including and related to natural products and climate (having suitable harbors)
3. Territorial extension (large enough to provide the necessary material wealth, but not so large as to be indefensible)
4. Population or number of inhabitants (sufficient to provide manning or crews)
5. Character of the people (degree of maritime awareness)
6. Character of the government, including national institutions (willingness to support a progressive naval policy) (Mahan, 1980, pp. 32 and ss.)

Accordingly, maritime power constitutes the ability to create, develop, exploit, and defend a country's maritime interests in conditions of peace and scenarios of armed conflict. In other words, maritime power consists of maritime interests combined with sufficient naval power to defend and protect them (Mahan, 1980).

Maritime power is also interpreted as the broad expression of a nation's capacity to make use of the sea in its political, economic, and cultural projection (George, 1980). For Chile's naval doctrine, this power consists in

> […] the ability to create, develop, exploit, and defend a country's maritime interests, both in peace and in war. In the broadest sense, it is political, economic, and military power or influence exercised through the ability to use the sea to one's advantage. That is, it corresponds to the influence that, by virtue of that power, a country can exert, at or from the sea, on events affecting its interests, wherever they may be. (Armada de Chile, 2009, p. 47)

The above coincides with the following assessment:

> A nation's maritime power is the broad expression of its capacity to make use of the sea in its political, economic, and cultural projection. The maritime and cultural awareness of its people is not alien to maritime power. In fact, it is the lifeblood that nourishes all maritime interests and naval power itself. (Pertusio, 1989, p. 24)

The maritime power equation comprises a set of factors that condition the achievement of political objectives in the field of maritime interests, interests whose deter-

mination, development, and security are linked to the use of the sea (Blanco, 1996, p. 1). These factors are as follows:

- Maritime awareness or national character understood as an understanding of the extent to which one depends on the sea for life and safety
- The geomaritime complex, which is given by the geographical situation, the physical configuration, and the merchant marine (commercial, fishing, and sports)
- Infrastructure for the exploitation of marine resources
- Economic potential
- Naval power made up of ships and bases

In any case, it should be noted that this is a relative concept. Some countries are better positioned than others, constituting a strategically significant relationship in times of peace and times of war (Till, 2007, p. 27). Hence, the paramount importance of finding a model against which to measure it (Moloeznik, 2009; 2010; 2012; Cuervo & Moloeznik, 2017).

Maritime interests

A retired rear admiral of the Argentine Navy defines a nation or state's maritime interests as "all aspects related to its security and development linked to the sea" (Pertusio, 1989, p. 19). The Chilean Navy (2009) defines maritime interests as

> […] the set of political, economic, social, and military benefits that a nation derives from all activities related to the use of the sea. These are carried out in the high seas, jurisdictional waters, seabed, and coastline, both by the state and by private parties, in order to take advantage of their facilities and exploit the resources contained therein. (p. 36)

In general, the preservation and security of maritime communication routes, the exploitation of the sea's riches, sun and beach tourism, and the use of the sea in the international political order, among others, constitute, as a whole, the relevant maritime interests for any sovereign state with maritime spaces valued for their strategic commercial value, generating wealth and benefits, and ultimately constituting fundamental factors for a country's economic development (Vargas, 2019, p. 10). From the economic development and growth perspective, these interests are identified in the merchant navy —generally made up of ships for maritime commerce— including tourism, fishing, and leisure marinas, the national port system, and the shipping industry, among others (Mahan, 1980).

Thus, every country should seek to define its maritime interests to promote their efficient and effective progress, considering the interrelationship between security and national development, which as state and power objectives constitute the means to achieve them (Vargas, 2019, p. 10). This explains why the existence of maritime interests obliges coastal states to make use of the sea. This use, for Mahan and Corbett, should be based on a "strategy for maritime control seeking to seize control of the sea; deny it to the opponent and allow the ships themselves, both military and civilian, to operate smoothly" (Burilkov & Geise, 2013, p. 1042).

The following two intangibles stand out within the framework of these interests: a) the people's maritime conscience, which can be conceived as the lifeblood that nourishes maritime interests (Pertusio, 1989, p. 24); and b) the national will of people and government to use the benefits provided by the sea like an engine that energizes and enhances maritime interests. Without this national will, achieving the maritime objectives of security and development becomes challenging (Moloeznik, 2010, pp. 1-2; Thiago, 1991, p. 3). Hence, the following should be recognized:

> […] the degree of understanding of the maritime environment and the opportunities that the sea offers to those who use it allows for the valorization of maritime interests and conditions maritime awareness, which is why these are the factors that have the greatest influence on the essence of maritime power. (Armada de Chile, 2009, p. 31)

Naval power

According to Pertusio (1989)

> Naval power has its raison d'être in support of these maritime interests. It would make no sense to have a Navy if there were no maritime interests, but, congruently, the capabilities of a country's naval power must agree with the strategic value of the mentioned interests for the nation. (p. 19)

Suitably, it can be stated that naval power constitutes a state's necessary coercive means to preserve its maritime interests and guarantee what the Law of the Sea and other international legal instruments recognize. Naval power is, therefore, the military expression of a nation-state's national power at sea. It supports its national maritime interests for the overall achievement of permanent national security and development objectives (Vargas, 2019).

In this sense, naval power is essential to achieving political goals. It can also be used by states to effectively establish and protect their global position, emphasizing

the ability to extend their influence and soft power worldwide, with the economic and political benefits that this can bring (Burilkov & Geise, 2013).

This naval power is embodied in the Navy, a component of maritime power whose purpose is to protect and preserve maritime richness. It is an instrument of power of the nation-state whose activities must be determined following the resources allocated and the missions entrusted to it (Sheina, 1991, p. 15).

Now, according to De Saint, a senior officer of the French Navy, a navy is first and foremost a set of means: ships, aircraft, support, then, the personnel needed to function them. Although it pains to give primacy to the means over the personnel, this does not imply denying that the personnel are the greatest wealth of naval power. However, it is the means that, unlike other armed forces, determine a navy's structure, architecture, and model (De Saint, 1994, p. 57).

In this regard, aircraft carriers, destroyers, and frigates are recognized as navies' main surface combat forces. Ships are the very essence of the navy. Thus, a navy may lack aircraft, helicopters, submarines, and marines, but a navy without ships is inconceivable (Cuervo & Moloeznik, 2017, p. 293).

At this point, the classic British naval doctrine makes its appearance. It classifies navies according to their naval power, symbolically, by the color of waters (Moloeznik, 2009; 2010; 2012):

- Blue Water Navy: 1) the United States; 2) the United Kingdom of Great Britain, France, Russia, India, and Japan.
- Green Water Navy: 1) China and Brazil (rising powers); 2) Colombia, Venezuela, and Mexico (coast guards with oceanic projection capabilities).
- Brown Water Navy: 1) Guatemala, Honduras, and El Salvador (naval forces); 2) Bolivia and Paraguay (river forces)

In a recent effort to measure the naval power of the region's navies, it was concluded that the countries with the highest naval power index in Latin America are Chile, followed by Peru, Brazil, Ecuador, Mexico, Argentina, Venezuela, Colombia, and Cuba, consecutively (Cuervo & Moloeznik, 2017, p. 313).

Navies, synonymous with naval power, exist primarily to ensure the nation-state's use of the sea for its own benefit and to prevent third parties from using it to the detriment of its maritime interests (Booth, 1980, p. 20). This idea draws on Mahan's classic work, which argues that naval power has been presented as a vital constant for national aggrandizement, prosperity, and security throughout the nations' history. "It can be said, as a general rule, that the *use and control of the sea* is and has always been a major factor in the history of the world" (Mahan, 1980, p. 13).

From a traditionalist perspective of national security as protection of the states' survival, maritime power aims to define the role of naval forces and develop strategies for their use. In peacetime, warships primarily focus on protecting central sea lines of communication to facilitate trade and economic prosperity through deterrence, surveillance, and interdiction (Bueger, 2015, p. 2; Cuervo, 2014; Vargas, 2018).

Thus, for the former Soviet Union's naval doctrine:

> It is reasonable to consider that the totality of the means of harnessing the world ocean and the means of defending the interests of the state, when rationally combined, constitute the maritime power of the state, which determines the ability of a particular country to use the military-economic possibilities of the oceans for its own purposes. (Gorshkov, 1979, p. ix)

This conception includes maritime power, represented by all the state's means at sea, providing the necessary capacity to achieve its purposes. Hence, it can be said that "the naval power of a State, together with the maritime interests of that State, make up its maritime power" (Pertusio, 1989, p. 19).

Maritime safety

The concept of *maritime safety* refers to the safety of ships and maritime installations, purposed to protect the universe of naval professionals and the maritime environment itself. Foremost, it involves regulating the ships and maritime facilities' construction, the regular control of their safety procedures, and naval world professionals' training, following the established regulations (Bueger, 2015, p. 3).

Given the above, maritime safety is also linked to economic development. Throughout history, the oceans have always been of vital economic importance.

> […] more than 90 % of international trade, in volume, is carried out by sea, and it is estimated that this will increase as the world population grows, as it is the most economical form of transportation. Maritime transport is a pillar of the global economy. Without it, trade in food, raw materials, and manufactured goods would be almost impossible; it is also essential for countries to protect and promote this important economic activity. The implicit relationship between nations' security and economic aspects has been observed. (Vargas, 2019, p. 10)

Especially today, both shipping and global fisheries have become highly valuable economic activities. Furthermore, the oceans' commercial weight has been re-evaluated given marine resources' potential economic status, including fossil energy reserves, seabed mining, and the economy generated by coastal tourism (Bueger, 2015, p. 4).

The above is linked to the so-called command of the sea, meaning "the control of maritime communications, whether for commercial or military purposes." Therefore, "the objective of naval warfare is the control of communications, and not, as in the case of land warfare, the conquest of territory" (Corbett, 1988, p. 42).

Methodology

Based on the above conceptual framework, the following methodology was used to propose a model for measuring the maritime power of nations. To do so, the most convenient process to answer the research questions was considered. It was determined to conduct the research using a predominantly mixed *qualitative* approach, based on the interpretation of categories that emerged from the information gathered under the grounded theory.

The qualitative model's consistency was checked using the following *quantitative* methods to allow its operationalization. These methods' justification is the need to recognize, through diagnosis, what the relationship is between *national maritime development*, *maritime safety*, and *maritime power*, and determine the sense in which this theoretical relationship exists.

Several authors refer to methodological complementarity and pluralism, highlighting its importance and necessity, determined by the requirements outlined in the research objectives (Pérez, 2002). Ruiz (2012) points out that "qualitative methodology is not incompatible with quantitative methodology; it requires a reconciliation between the two," recommending combining them in the cases and methodological aspects that call for it (p. 17).

Proposal for a model to measure the maritime power of nations

Type of measurement model developed under a quantitative-scientific approach

For the proposal of the measurement model, the first step was to determine which type of model was the most appropriate to operationalize the qualitative analysis' results, following the proposal of Heckbert et al. (2010, cited by Cardoso et al., 2011, p. 7) (Figure 1).

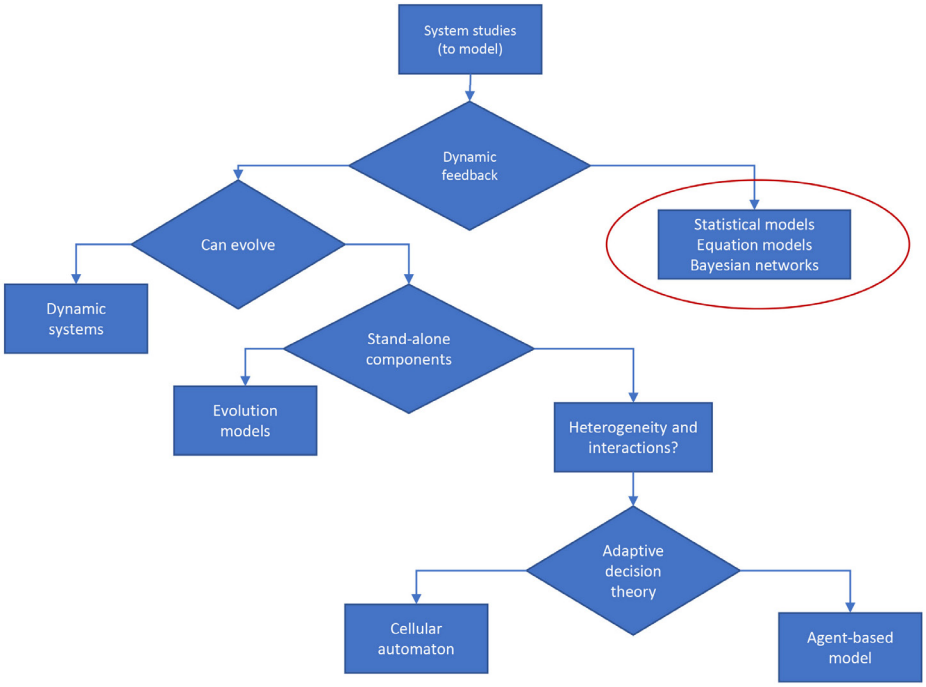

Figure 1. Type of model best suited to operationalize the qualitative analysis results. Source: Cardoso et al. (2011, p. 7).

On this basis, the linear equation model was selected, as no dynamic data feedback is contemplated.

Main equations

The second step was to construct the main equations based on establishing the object of study and, consequently, the variables to be measured. Thus, according to the qualitative model developed, *national maritime development* was identified as the *object of study*. One dependent variable and two independent variables were identified in the quantitative approach, namely:

Dependent variable: *Vd1 = national maritime development (NMD)*

Independent variables: *Vi1 = maritime safety (MS)*

Vi2 = maritime power (MP)

Conceptual definition of variables

Vd1 = national maritime development (NMD)

National maritime development is a country's achieved level of organization, infrastructure, and economic growth through the defense, security, use, and rational exploitation of the maritime richness and interests at its disposal. It considers the fulfillment of current needs without compromising future generations' ability to satisfy their own.

Vi1 = maritime safety (MS)

Maritime security is the condition of safety generated in all activities carried out in the maritime field through nation-state actions and strategies implemented to eliminate, reduce, or mitigate arising risks and threats.

Vi2 = maritime power (MP)

Maritime power is a nation-state's ability, through political will, to use and exploit the current and potential wealth and resources shaped as maritime interests in an environment of maritime security provided by the country's civil and naval authorities.

Operational definition of variables

Concerning the operational definition of the three variables, expressed generally, the following results were obtained.

Vd1 = national maritime development (NMD)

NMD is the result of the algorithm that sums the indexes that measure the indicators. That is, human capital (*hC*), plus physical capital (*pC*), plus gross domestic product (*GDP*) multiplied by the sum of the technologies (Tec) with the index of the legal framework (*Lf*). This algorithm was constructed during the development of this research and was solved using a computer tool in Excel, resulting in the following synthesized formula:

$$\mathrm{NMD} = (\mathrm{hC} + \mathrm{pC} + \mathrm{GDP})(\mathrm{Tec} + \mathrm{Lf}) \qquad \textit{Equation 1}$$

Vi1 = maritime safety (MS)

MS is the result of the algorithm that relates the indexes that measure the following indicators: multidimensional security (*mS*) minus the risks and threats (*RaT*) (Equation 2):

$$\mathrm{MS} = \mathrm{mS} - \mathrm{RaT} \qquad \textit{Equation 2}$$

Vi2 = maritime power (MP)

MP is the result of the algorithm that relates the indexes that measure the following indicators: maritime interests (*mI*) plus maritime assets (*mR*) (Equation 3):

$$MP = mI + mR \qquad \textit{Equation 3}$$

Research hypothesis

The following working hypothesis was established to guide this research work's quantitative aspect: national maritime development is directly related to maritime safety; the greater the maritime safety, the greater the national maritime development.

The most suitable indexes

The third step was to select the most appropriate indexes based on the indicators proposed in the theoretical model, considering the following points:

1. Awareness of the available information, including, if possible, the methodology for constructing the statistics used.
2. Validity of the series to be used in the analysis.
3. Frequency, including publication date and latest data, prioritizing data obtained in more recent years.
4. Availability to rapidly obtain essential information to carry out the studies.
5. Statistical quality of the procedure regarding length and homogeneity for creating the indexes.
6. Type of frequency establishes that the higher the series' temporal frequency, the higher its information content.
7. Stability implies that the variables' profile smoothness is essential to obtain a good indicator. Conversely, unexpected high volatility suggests that the series has undergone methodological or criterion changes in its preparation.
8. Completeness relates to the number of components that must represent all the properties related to the objective sought by the global indicator through the components.
9. Objectivity, meaning that the information in the indexes has no underlying intention.
10. Comparability, which, for the sake of the objective measured by the indicator, assumes that all countries or regions are comparable.

The selected indexes met the required validity, reliability, and universality following these criteria and were established as shown in Annex I.

In building an operationalizing algorithm to the proposed theoretical model, the sustainability of national maritime development, maritime security, and maritime power must be understood as a complex problem with linear and nonlinear relationships between its factors. In intuitive terms, for instance, this means that the higher the levels of maritime security, the greater the benefits for a state's maritime development.

Some basic notions of the modeling process should be considered to avoid incurring mathematical technicalities and facilitate the proposed model's communication (Carrasco & Vivanco, 2013). Understanding the problem statement and computational simulations requires at least a basic understanding of the mathematical modeling process.

Figure 2 shows how the factors corresponding to each of the variables analyzed were related and their mathematical relationship.

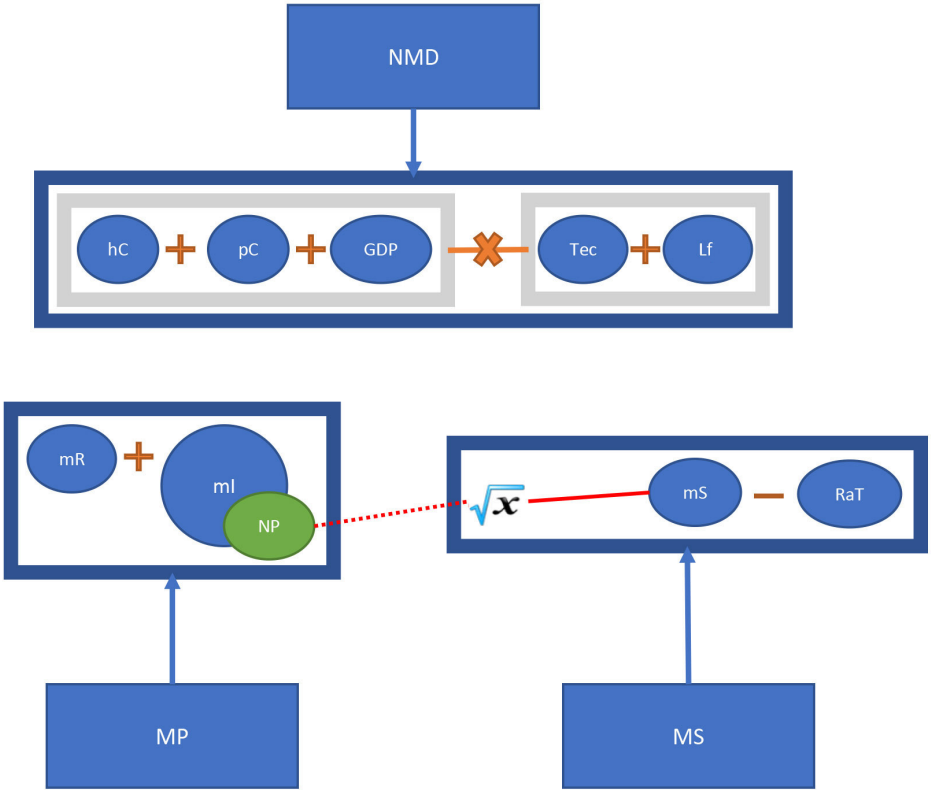

Figure 2. Mathematical relations of the theoretical model.
Source: Created by the authors.

Based on these results, three initially separate, important sets are formed with an underlying relationship of the square root of naval power (*NP*), which multiplies the multidimensional security value, integrated into the final value of maritime security.

At the same time, 33 indexes were considered for the selected indicators, which were integrated into the following algorithms (See Annex II).

National maritime development (NMD)

According to its operational definition, national maritime development is composed of the following indicators:

$$\mathrm{NMD} = (\mathrm{hC} + \mathrm{pC} + \mathrm{GDP})(\mathrm{Tec} + \mathrm{Lf}) \qquad \textit{Equation 1}$$

Human capital (*hC*), of three indexes:

$$HC = Pcz(\mathrm{HDi} + \mathrm{hCi}) \qquad \textit{Equation 4}$$

Index: Human development (*HDi*)
Source: Human Development Report Office
Periodicity: Annual
Units: Decimal index
Observations: 2019

Index: Human capital (*hCi*)
Source: Global Human Capital Index 2017
Periodicity: Annual
Units: Decimal index
Observations: 2017

Index: Population in coastal zones (*Pcz*)
Source: World Bank
Periodicity: Annual
Units: Population living in areas where elevation is less than 5 meters (% of total population)
Observations: 2017

Physical capital (*pC*), with two indexes:

$$pC = COi * Inf \quad \textit{Equation 5}$$

Index: Competitiveness *(COi)*
Source: The Global Competitiveness Report
Periodicity: Annual
Units: Scale from 1 to 7
Observations: 2019

Index: Port infrastructure (*Ip*)
Source: World Bank
Periodicity: Annual
Units: Scale from 1 to 7
Observations: 2017

Gross Domestic Product (*GDP*), with two indexes:

$$GDP = tGDP + GDPg \quad \textit{Equation 6}$$

Index: Total gross domestic product (*tGDP*)
Source: World Bank
Periodicity: Annual
Units: Millions of dollars
Observations: 2019

Index: Gross domestic product in goods (*GDPg*)
Source: World Bank
Periodicity: Annual
Units: Percentage in relation to annual GDP
Observations: 2019

Technologies (*Tec*), with two indexes:

$$Tec = In * i\&D \quad \textit{Equation 7}$$

Index: Innovation (*In*)
Source: World Bank
Periodicity: Annual
Units: Scale from 0 to 100
Observations: 2020

Index: Investment and development spending (*i&D*)
Source: World Bank
Periodicity: Annual
Units: Percentage in relation to annual GDP
Observations: 2017

Legal Framework (*Lf*), with an index:

$$Lf = GOVi \qquad \textit{Equation 8}$$

Index: Governance (*GOVi*)
Source: Forum for a new World Governance (FnWG)
Periodicity: Annual
Units: Scale from 0 to 1
Observations: 2011

Maritime safety (SM)

Maritime safety (*MS*) is composed of the following indicators:

$$\mathrm{MS} = (\mathrm{mS} - \mathrm{RaT}) * \sqrt{\mathrm{NP}} \qquad \textit{Equation 9}$$

Multidimensional security (*mS*), divided into:

$$mS = Pt * Sc \qquad \textit{Equation 10}$$

Index: Global peace (*Pt*)
Source: Institute for Economics and Peace
Periodicity: Annual
Units: Index composed of 23 indicators
Observations: 2020

Index: Internal and police security (*Sc*)
Source: World Internal Security & Police Index
Periodicity: Annual
Units: Scale from 0 to 10
Observations: 2016

Risks and Threats (*RaT*), divided into:

$$RaT = Mp(Po + Terr) + (Corr * frS) \qquad \textit{Equation 11}$$

Index: Marine pollution (*Mp*)
Source: United Nations Office on Drugs and Crime
Periodicity: Annual
Units: Number of crimes
Observations: 2011

Index: Poverty and inequality (*Po*)
Source: World Bank
Periodicity: Annual
Index: Scale from 0 to 100
Observations: 2018

Index: Global terrorism (*Terr*)
Source: National Consortium for the Study of Terrorism and Responses to Terrorism (START)
Periodicity: 10 years
Units: Scale from 0 to 10
Observations: 2014

Index: Perception of corruption (*Corr*)
Source: Transparency International
Periodicity: Annual
Units: Scale from 0 to 100
Observations: 2019

Index: Fragility of the State (*frS*)
Source: The Fund for Peace (FFP)
Periodicity: Annual
Units: Scale from 0 to 100
Observations: 2019

Maritime Power (MP)

Maritime power (*MP*) is composed of the indicators shown in Equation 3:

$$MP = mI + mR \qquad \textit{Equation 3}$$

Maritime interests (*mI*), with five indexes:

$$Im = PN\ (Com + Tur + Pet + Pes)$$

Naval Power (*NP*), with an index:

$$NP = 100\left(\frac{300Ac+100Cr+33.3FF+8.4DD+4.2SS+1.4Cov+0.7Pcos+0.3Bm}{30000}\right) \qquad \textit{Equation 12}$$

Index: Naval Power (*NP*)
Source: Self-developed measurement model
Periodicity: Annual
Units: Measuring scale from 0 to 30
Observations: 2020

Maritime trade (*Com*), with two indexes:

$$Com = mcT + lP \qquad \textit{Equation 13}$$

Index: Maritime container traffic (*mcT*)
Source: World Bank
Periodicity: Annual
Units: Millions of 20-foot units
Observations: 2018

Index: Logistics performance (*lP*)
Source: World Bank
Periodicity: Annual
Units: Scale of 1 to 5
Observations: 2018

Maritime Tourism (*Tur*), with three indexes:

$$\mathrm{Tur} = \mathrm{Sc}(\mathrm{eT} + \mathrm{iT}) \qquad \textit{Equation 14}$$

Index: International tourist arrivals (*eT*)
Source: World Tourism Organization
Periodicity: Annual
Units: Millions of people
Observations: 2018

Index: Revenue from international tourists (*iT*)
Source: World Tourism Organization
Periodicity: Annual
Units: Millions of dollars
Observations: 2018

Index: Surface area of coastland (*Sc*)
Source: World Bank
Periodicity: Every 10 years
Units: % of total area
Observations: 2010

Oil (*Pe*), with three indexes:

$$Pe = eO + Op + pR \qquad \textit{Equation 15}$$

Index: Oil exports (*eO*)
Source: World Bank
Periodicity: Annual
Units: Percentage of exports
Observations: 2019

Index: Number of oil platforms (*Op*)
Source: National Petroleum Corporation
Periodicity: Annual
Units: Number of offshore oil platforms
Observations: 2018

Index: Proved oil reserves (*pR*)

Source: Organization of the Petroleum Exporting Countries (OPEC)

Periodicity: Annual

Units: Billions of barrels of oil

Observations: 2020

Fishing (*Fis*), with two indexes:

$$Fis = mP + \sqrt{aP}$$ *Equation 16*

Indicator: Marine capture production (*mP*)

Source: United Nations (FAO)

Periodicity: Annual

Units: Millions of tons

Observations: 2018

Indicator: Aquaculture production (*aP*)

Source: United Nations (FAO)

Periodicity: Annual

Units: Millions of tons

Observations: 2018

Maritime Richness (*Mr*):

$$Mr = 10(lKc + cS + Zp + eeZ) + 2.5Ra$$ *Equation 17*

Index: Linear kilometers of coastline (*lKc*)

Source: Sea Around Us - Fisheries, Ecosystem and Biodiversity

Periodicity: Annual

Units: Square kilometers

Remarks: 2016

Index: Continental shelf (*cS*)

Source: Sea Around Us - Fisheries, Ecosystem and Biodiversity

Periodicity: Annual

Units: Square kilometers

Observations: 2016

Index: Fishing zones (*fZ*)
Source: Sea Around Us - Fisheries, Ecosystem and Biodiversity
Periodicity: Annual
Units: Square kilometers
Observations: 2016

Index: Exclusive economic zone (*eeZ*)
Source: Sea Around Us - Fisheries, Ecosystem and Biodiversity
Periodicity: Annual
Units: Square kilometers
Observations: 2016

Index: Reef area (*Ra*)
Source: Sea Around Us - Fisheries, Ecosystem and Biodiversity
Periodicity: Annual
Units: Square kilometers
Observations: 2016

Standardization of values and sample selection

Once selected, the indexes' values needed to be standardized so that the same unit of measurement represented each factor. The values for each index were added for the countries that made up the population of the quantitative study. The sum of the total values yielded each country's percentage of the index measured was obtained. Ultimately, all the indexes involved were given in percentage units.

The developed mathematical model was digitized in Excel to continue with the hypothesis testing and the presentation of the quantitative approach results. After concluding the approach, a sample of the countries to be analyzed was selected, taking 194 countries as the population.

Table 1. Quantitative analysis of countries with their naval power index (NP) value

Country	NP	Country	NP	Country	NP	Country	NP
United States	23.60	Nigeria	0.23	Slovenia	0.00	Laos	0.00
China	10.59	Belgium	0.23	Estonia	0.00	Kosovo	0.00
France	5.71	Argentina	0.21	Congo	0.00	Maldives	0.00
Japan	5.46	Azerbaijan	0.20	Switzerland	0.00	Gambia	0.00
South Korea	4.96	Bahrain	0.20	Austria	0.00	Congo	0.00
Russian Federation	3.93	Israel	0.19	Barbados	0.00	Grenada	0.00
United Kingdom	3.81	Qatar	0.16	Vanuatu	0.00	Brunei Darussalam	0.00
Italy	3.60	Sri Lanka	0.15	Iceland	0.00	Latvia	0.00
India	3.36	Ukraine	0.13	Ireland	0.00	Mauritania	0.00
North Korea	3.34	Bolivia	0.13	Czech Rep.	0.00	East Timor	0.00
Australia	3.06	Honduras	0.13	Slovak Rep.	0.00	Seychelles	0.00
Egypt	3.05	Uruguay	0.12	Cyprus	0.00	Togo	0.00
Thailand	2.37	Libya	0.11	Botswana	0.00	Haiti	0.00
Spain	2.32	Angola	0.09	Hungría	0.00	New Guinea	0.00
Turkey	2.08	Tunisia	0.07	Montenegro	0.00	Sao Tome and Principe	0.00
Iran	2.07	Jordan	0.06	Costa Rica	0.00	Chad	0.00
Greece	1.68	Iraq	0.05	Rwanda	0.00	Tonga	0.00
Canada	1.43	Nicaragua	0.05	Bosnia and Herzegovina	0.00	St. Vincent	0.00
Chile	1.35	Cambodia	0.05	Mongolia	0.00	Solomon Islands	0.00
Colombia	1.33	Oman	0.05	Trinidad and Tobago	0.00	Saint Lucia	0.00
Indonesia	1.33	Turkmenistan	0.04	Jamaica	0.00	Dominica	0.00
Vietnam	1.21	Albania	0.04	Ivory Coast	0.00	Niger	0.00

Table continues...

Country	NP	Country	NP	Country	NP	Country	NP
Pakistan	1.15	United Arab Emirates	0.04	Lesotho	0.00	Belize	0.00
Germany	1.12	Finland	0.04	Cape Verde	0.00	Saint Kitts and Nevis	0.00
Denmark	1.04	Paraguay	0.04	Armenia	0.00	Eritrea	0.00
Bangladesh	1.02	Dominican Rep.	0.03	Benin	0.00	Comoros	0.00
Brazil	0.92	Cameroon	0.03	Bahamas	0.00	Djibouti	0.00
Peru	0.88	Lebanon	0.03	Senegal	0.00	Fiji	0.00
Myanmar	0.85	Kazakhstan	0.03	Swaziland	0.00	Central African Rep.	0.00
Mexico	0.75	Somalia	0.03	Guyana	0.00	Afghanistan	0.00
Singapore	0.73	Sudan	0.03	Tajikistan	0.00	San Marino	0.00
Singapore	0.72	Ghana	0.03	Moldova	0.00	Antigua / Barbuda	0.00
Algeria	0.71	Tanzania	0.02	Luxembourg	0.00	Samoa	0.00
Portugal	0.62			Nepal	0.00	Micronesia	0.00
Norway	0.59	Yemen	0.02	Belarus	0.00	South Sudan	0.00
Morocco	0.59	Guatemala	0.02	Zambia	0.00	Andorra	0.00
South Africa	0.56	Sierra Leone	0.02	Malawi	0.00	Vatican	0.00
Venezuela	0.55	Serbia	0.02	Mauritius	0.00	Marshall Islands	0.00
Bulgaria	0.49	Panama	0.02	Kyrgyzstan	0.00	Kiribati	0.00
Sweden	0.48	Uganda	0.02	Burkina Faso	0.00	Liechtenstein	0.00
Philippines	0.40	Madagascar	0.02	Mali	0.00	Monaco	0.00
Saudi Arabia	0.38	Croatia	0.02	Liberia	0.00	Nauru	0.00
Malaysia	0.38	Georgia	0.02	Equatorial Guinea	0.00	Palau	0.00
Romania	0.36	Mozambique	0.01	Ethiopia	0.00	Tuvalu	0.00
Poland	0.30	Namibia	0.01	Uzbekistan	0.00	Zimbabwe	0.00
Cuba	0.30	Kenya	0.01	Malta	0.00		

Table continues...

Country	NP	Country	NP	Country	NP	Country	NP
Ecuador	0.29	**Lithuania**	0.01	**Bhutan**	0.00		
Syria	0.26	**El Salvador**	0.01	**Guinea**	0.00		
Kuwait	0.25	**Gabon**	0.01	**Burundi**	0.00		
New Zealand	0.24	**Suriname**	0.01	**Guinea-Bissau**	0.00		

Source: Created by the authors.

The sample selection was based on considering a non-probabilistic-discretionary type of sampling, under the criterion of considering only those countries that obtained a naval power index higher than 0.

It should be noted that this sampling type is typically used when selecting subjects with certain characteristics is necessary. In this regard, Kerlinger & Lee (2002) point out that non-probability sampling is necessary and essential on many occasions and that probability sampling is not necessarily superior.

Once the countries making up the sample were defined, the values of all the indexes used in the proposed model were obtained to conduct the reliability test. The internal reliability criterion was used for this calculation, following Cronbach's Alpha coefficient method, based on the variance of the items.

Where:

α: Cronbach's alpha reliability coefficient

K: number of items or questions in the questionnaire = 65

S2: Sum of the variances of the items.

The matrix of coded data and variance calculations, whose values were incorporated in the above formula, yielded α = 0.709 for 49 items, using the SPSS statistical program. To interpret this, it is worth noting that the reliability of an instrument is expressed by a correlation coefficient whose values range from zero (0) to one (1.00). One way to interpret its magnitude is shown in Table 2.

Table 2. Interpretation of reliability coefficient

Range	Magnitude
0.81 a 1.00	Very high
0.61 a 0.80	High
0.41 a 0.60	Moderate
0.21 a 0.40	Low
0.01 a 0.20	Very low

Source: Created by the author.

Based on the results obtained, the instrument designed for data collection had *high reliability*. The dimensions of naval power considered by the international publications were carefully reviewed to verify its validity. They mainly included the *IHS Jane's Fighting Ships 2013-2014* (Saunders, 2013a; 2013b); the *US Navy* (2012) illustrated encyclopedia, published by the Department of State of the United States of America; the *Guide to naval power in the world* by Wragg (2012), the specialized texts by Camil Busquets (2012) and Octavio Díez (2006), and the updated guide, *Warships* by Chris Chant (2006).

With the model validated, we proceeded to evaluate the 99 countries in the sample's national maritime development and maritime safety, separated into two sections. Group A included the countries with the highest maritime safety index (Table 3); Group B was the countries with the lowest index (Table 4).

Table 3. Group A: high maritime safety

Country	MS	NMD	Country	MS	NMD
Singapore	2.38	0.56	**Kuwait**	1.62	0.34
Denmark	2.31	6.52	**France**	1.58	2.63
New Zealand	2.29	0.92	**Bulgaria**	1.58	0.47
Finland	2.22	2.20	**Chile**	1.51	0.28
Australia	2.17	1.97	**Serbia**	1.44	0.34
Canada	2.14	1.73	**Jordan**	1.44	0.12
Portugal	2.13	1.05	**Greece**	1.43	0.70
Japan	2.11	7.12	**Georgia**	1.34	0.26
Germany	2.10	5.31	**Vietnam**	1.24	2.01
Sweden	2.08	2.43	**Bahrain**	1.24	0.98
Norway	2.07	1.80	**United States of America**	1.17	15.11
Netherlands	2.06	0.25	**Panama**	1.15	0.23
Belgium	1.97	4.89	**Albania**	1.14	0.28
Poland	1.79	0.85	**Sri Lanka**	1.14	0.15
Croatia	1.79	0.54	**Kazakhstan**	1.09	0.12
Spain	1.77	0.41	**Argentina**	1.07	0.33
United Kingdom	1.71	2.81	**Indonesia**	1.04	0.40
United Arab Emirates	1.69	2.36	**Algeria**	1.03	0.17
Romania	1.66	0.25	**Tunisia**	1.03	0.59

Table continues...

Country	MS	NMD	Country	MS	NMD
South Korea	1.66	5.13	**Saudi Arabia**	1.02	0.27
Italy	1.64	1.73	**Ecuador**	0.98	0.23
Uruguay	1.63	0.39	**Azerbaijan**	0.96	0.16
Lithuania	1.63	0.75	**Thailand**	0.95	0.42
Malaysia	1.63	0.34	**Cambodia**	0.93	0.27

Source: Created by the authors.

Table 4. Group B: Low maritime safety

Country	MS	NMD	Country	MS	NMD
Morocco	0.93	0.16	**Colombia**	0.59	0.17
Dominican Republic	0.92	0.00	**Mexico**	0.52	0.37
Ghana	0.91	0.15	**India**	0.52	0.67
Tanzania	0.86	0.07	**Uganda**	0.52	0.06
Israel	0.85	2.65	**Cameroon**	0.46	0.06
El Salvador	0.84	0.12	**Kenya**	0.44	0.08
China	0.84	7.85	**Russia**	0.42	0.89
Madagascar	0.83	0.11	**Sudan**	0.41	0.06
Sierra Leone	0.83	0.09	**Venezuela**	0.36	0.07
Peru	0.81	0.16	**Pakistan**	0.32	0.12
South Africa	0.80	0.15	**Nigeria**	0.25	0.13
Egypt	0.78	0.99	**Yemen**	0.20	0.03
Paraguay	0.78	0.09	**Syria**	0.00	0.00
North Korea	0.75	0.00	**Qatar**	–0.01	0.91
Bolivia	0.74	0.04	**Oman**	–0.01	0.38
Brazil	0.72	0.74	**Cuba**	–0.02	0.03
Guatemala	0.70	0.09	**Namibia**	–0.02	0.19
Bangladesh	0.66	0.23	**Suriname**	–0.02	0.65
Philippines	0.66	0.25	**Gabon**	–0.03	0.15
Honduras	0.65	0.14	**Ukraine**	–0.03	0.31

Table continues...

Country	MS	NMD	Country	MS	NMD
Myanmar	0.65	0.18	**Turkmenistan**	–0.03	0.00
Iran	0.65	0.13	**Angola**	–0.04	0.05
Nicaragua	0.62	0.14	**Libya**	–0.04	0.21
Lebanon	0.61	0.12	**Iraq**	–0.05	0.15
Mozambique	0.61	0.19	**Somalia**	–0.06	0.00
Turkey	0.61	0.19			

Source: Created by the authors.

Hypothesis testing

After the operationalization of the qualitative model was completed and Groups A and B were identified, we proceeded to test the hypothesis proposed, namely, that national maritime development is directly related to maritime safety; the greater the maritime safety, the greater the national maritime development.

Following the proposal developed by Ortiz (2012), hypothesis testing allows checking whether there is sufficient statistical evidence to demonstrate the relationship between variables based on a perfectly validated inferential method, according to the following procedure.

Step 1: State the null hypothesis and the research hypothesis

It intends to demonstrate that the countries with the highest maritime safety rating (*iMS*) have a greater national maritime development (*iNMD*) index than countries with the lowest *iMS*. Thus, Group A's *iNMD* average must be greater than Group B's mean *iNMD*.

The alternative hypothesis statement would be:

$$H_1: \mu(\text{iNMD A}) - \mu(\text{iNMD B}) > 0 \qquad \textit{Equation 19}$$

The null hypothesis would be as follows:

$$H_0: \mu(\text{iNMD A}) - \mu(\text{iNMD B}) \leq 0 \qquad \textit{Equation 20}$$

Step 2: Determine the significance level

The significance level indicates the probability of rejecting when it is true and is defined by the Greek letter α. In general, a value of 0.05 is considered for research projects; this the value assigned in this work.

Step 3: Sample evidence

This step refers to the calculation of the sample's mean (μ) and standard deviation (σ):

$$\sigma = \frac{\sqrt{\sum |X-\mu|^2}}{n} \qquad \textit{Equation 21}$$

Results

From the countries in the region considered the population for this study, nine were selected as the sample because of their armed forces' prominence. The corresponding analysis was carried out. The results obtained from the nine countries with powerful armadas in Latin America are presented below.

It should be noted that the measurement model uses the described variables to obtain the values of the following indexes:

- Current naval capabilities
- Potential naval capabilities
- Total naval power
- Type of navy
- National maritime richness index
- Police maritime defense index
- Naval defense index
- Percentage of maritime richness without current protection (against law violators)
- Percentage of maritime richness without current protection (against other naval forces)

In the first item, "Current naval capabilities," Chile is the country that currently has the highest index in this category. Graphically, the results are shown in Figure 3.

Country	Current capacities
Chile	23.95
Peru	17.1
Brazil	9.87
Venezuela	6.42
Ecuador	6.32
Argentina	4.94
Colombia	2.72
Cuba	1.63
Mexico	1.38

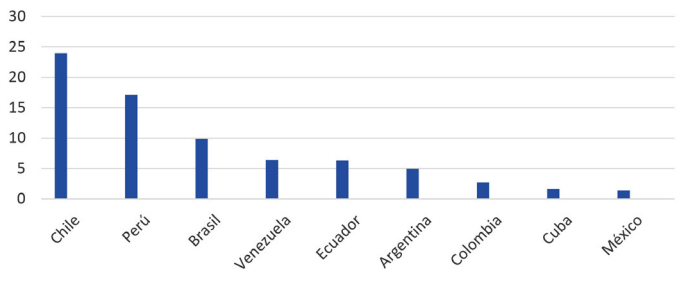

Figure 3. Current naval capabilities.
Source: Created by the authors.

Conclusions

In closing, it is worth remembering that maritime power is a relative concept; certain countries have more of it than others (Till, 2007, p. 27). This situation prompted proposing a model for measuring the nations' maritime power based on indices that would allow comparisons between nation-states with maritime interests to be preserved. Its relevance and application's usefulness are left to the readers' judgment.

This measurement model, generated based on 33 international indices combined through carefully designed algorithms, allows us to obtain percentage results that rank the 99 selected nation-states in order of priority according to the values of the indices captured in the model. These values and indices can be updated along with their sources, determining the variation in priority according to the desired category (development, security, or maritime power). Ultimately, this allows comparisons between countries and analyzing the areas in which they have improved or worsened, as shown in Table 5.

Table 5. Measurement model results

Country	MARITIME DEVELOPMENT				MARITIME POWER				MARITIME SAFETY			
	2017		2020		2017		2020		2017		2020	
	Position	Index	Position	Index	Position	Index	Position	Index	Position	Index	Position	Index
United States	1	13.44	1	15.11	1	17.80	1	19.56	35	1.21	35	1.17
Japan	2	7.54	3	7.12	9	3.34	8	3.03	10	1.97	8	2.11
China	3	6.10	2	7.85	2	13.04	2	13.52	65	0.72	55	0.84
Denmark	4	5.89	4	6.52	30	0.53	34	0.40	4	2.22	2	2.31
Germany	5	4.68	5	5.31	31	0.52	35	0.39	8	1.99	9	2.10
Singapore	6	4.33	32	0.56	44	0.26	48	0.19	7	2.08	1	2.38
Belgium	7	4.02	7	4.89	79	0.05	81	0.04	15	1.84	13	1.97
South Korea	8	3.53	6	5.13	27	0.63	21	0.90	63	0.72	20	1.66
United Kingdom	9	2.77	8	2.81	7	4.34	7	4.07	19	1.58	17	1.71
France	10	2.55	10	2.63	18	1.07	15	1.45	20	1.58	53	0.85
Sweden	11	2.13	11	2.43	38	0.34	38	0.34	9	1.98	10	2.08

Table continues...

Country	MARITIME DEVELOPMENT				MARITIME POWER				MARITIME SAFETY			
	2017		2020		2017		2020		2017		2020	
	Position	Index	Position	Index	Position	Index	Position	Index	Position	Index	Position	Index
Australia	12	2.11	15	1.97	4	6.26	5	6.10	5	2.14	5	2.17
Finland	13	2.09	13	2.20	56	0.17	55	0.17	6	2.09	4	2.22
Israel	14	1.92	9	2.65	86	0.02	86	0.02	48	0.89	53	0.85
United Arab Emirates	15	1.75	12	2.36	84	0.02	84	0.02	28	1.47	18	1.69
Canada	18	1.68	18	1.73	6	5.60	6	5.44	11	1.96	6	2.14
Spain	20	1.34	36	0.41	20	0.96	24	0.71	17	1.76	16	1.77
Malaysia	22	1.18	43	0.34	22	0.81	22	0.79	29	1.46	24	1.63
Brazil	31	0.70	27	0.74	11	1.82	11	1.70	58	0.80	64	0.72
India	35	0.59	29	0.67	8	3.56	9	2.76	76	0.52	77	0.52
Mexico	40	0.48	40	0.37	13	1.78	12	1.62	79	0.50	76	0.52
Indonesia	44	0.38	37	0.40	5	6.25	4	6.14	45	1.00	41	1.04
Chile	55	0.30	47	0.28	16	1.21	17	1.20	21	1.55	28	1.51
Netherlands	59	0.26	53	0.25	25	0.68	20	0.98	1	3.15	12	2.06
Colombia	69	0.18	62	0.17	39	0.31	33	0.44	78	0.51	75	0.59
Peru	70	0.17	65	0.16	34	0.42	32	0.46	60	0.77	58	0.81

Source: Created by the authors.

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Annex I. Selected indexes

PN	Indicator	Definition	Source
1	Human Development (HDi)	In every country, there are many people with little prospect of a better future. They lack hope, a sense of purpose, and dignity. From their marginalized situation, they can only look on as others prosper and grow richer and richer.	United Nations Development Program (UNDP), Human Development Report
2	Human Capital (hCi)	Provides a means to measure quantifiable elements of the world's talent potential so that greater attention can be focused on its delivery. It seeks to foster a true revolution in education systems to meet the needs of the future workforce through directed education by measuring countries' talent resources holistically. Instead of merely considering the formative years, it looks at the individuals' ability to acquire, develop, and deploy skills throughout their working lives.	Global Human Capital Index 2017
3	Population in Coastal Zones (Pcz)	Population growth in coastal zones pressures the marine environment mainly through infrastructure construction, its resources' overexploitation, and untreated municipal waste disposal in its waters.	World Bank
4	Competitiveness (COi)	This index is an annual criterion for policymakers to look beyond short-term reactionary measures and instead assess their progress against the full set of factors determining productivity. These are organized into 12 pillars: Institutions, Infrastructure, ICT Adoption, Macroeconomic Stability, Health; Skills, Product Market, Labor Market, Financial System, Market Size, Business Dynamism, and Innovation Capacity.	The Global Competitiveness Report
5	Port infrastructure (pI)	These are the civil works and mechanical, electrical, and electronic installations –fixed and floating– built or located in ports to facilitate transport and modal exchange.	World Bank

Table continues...

PN	Indicator	Definition	Source
6	Gross domestic product (GDP)	The GDP is the sum of the gross value added of all resident producers in the economy plus any taxes on products, minus any subsidies not included in the value of products. It is calculated without deductions for depreciation of manufactured goods or depletion and degradation of natural resources. GDP per capita is the gross domestic product divided by the population at mid-year.	World Bank
7	Gross domestic product in goods (GDPg)	The trade in goods as a share of GDP is the sum of goods exports and imports divided by the value of GDP, all in U.S. dollars and at current prices.	World Bank
8	Innovation	The innovative process through which institutions and civil society generate high-quality products, services, and ideas at a very low cost, including and benefiting people in vulnerable situations for their livelihood and consequent development.	World Bank
9	Investment and development spending	Percentage in relation to annual GDP.	World Bank
10	Gobernabilidad (Govi)	This indicator was developed in 2008 by the Forum for New World Governance (FnWG). It aims to provide, year by year, an accurate picture of the state of global governance and its evolution, based on the positions of each individual country and the world as a whole in terms of governance.	Forum for a new World Governance (FnWG)
11	Naval power	Naval power consists of the effective strength of a combination of naval forces, ships, aircraft, marines, and their commanders' competence, eventually, with the Merchant Navy to preserve and protect national interests in fluvial and maritime zones.	Proprietary measurement model

Table continues...

PN	Indicator	Definition	Source
12	Maritime container traffic	Container port traffic measures container flow from land to sea and vice versa, in units equivalent to 20-foot equivalent units (TEU), the standard container size. The data refers to cabotage transport, as well as international voyages.	World Bank
13	Logistics performance	The Logistics Performance Index (LPI) is a World Bank measurement to show and describe global trends in logistics. It uses a standardized questionnaire consisting of two parts: 1) international logistics and 2) domestic logistics.	World Bank
14	International tourist arrivals	International tourists from abroad (overnight visitors) are the number of tourists traveling to a country other than their place of residence, outside their usual environment, for a period not exceeding 12 months, and whose primary purpose in visiting is not a remunerated activity within the country visited.	World Tourism Organization
15	Revenue from international tourists	Tourism is an essential component of export diversification for both emerging and advanced economies. It has a solid capacity to reduce trade deficits and offset declining export earnings from other goods and services.	World Tourism Organization
16	Costal zone surface area	The land area below 5 meters. It is the percentage of the total land area where the elevation is 5 meters or less.	World Bank
17	Oil exports	Oil revenues as a GDP percentage obtained from exports to third countries.	Wold Bank
18	Number of oil platforms	The number of offshore oil platforms worldwide as of January 2018, by operator.	es.statista.com
19	Proved oil reserves	Proved reserves are the quantities of oil that, through analysis of geological and engineering data, can be estimated with a high degree of confidence to be commercially recoverable as of a given date, from known reservoirs, and under current economic conditions.	Organización de Países Exportadores de Petróleo (OPEP)

Table continues...

PN	Indicator	Definition	Source
20	Marine capture production	The 2018 State of World Fisheries and Aquaculture is based on FAO's official statistics on fisheries and aquaculture. World fisheries production peaked at approximately 171 million tonnes in 2016. Aquaculture accounted for 47% of the total, 53% if non-food uses are excluded, including fishmeal preparation reductions and fish oils.	Food and Agriculture Organization of the United Nations (FAO)
21	Aquaculture production	Global fish production peaked at approximately 171 million tons in 2016, of which aquaculture accounted for 47% of the total, 53% if non-food uses are excluded, including fishmeal preparation reductions and fish oils.	Food and Agriculture Organization of the United Nations (FAO)
22	Linear kilometers of coastline	The coastline is a double line comprised of the high and low tide lines. It horizontally delimits the transition zone between land and sea, where the tides are appreciable and muddled into one, although they are not. There is no transition zone given the land's verticality or permanent artificial construction, even if they are.	https://armada.defensa.gob.es/
23	Continental shelf	This is the surface under the sea and near the coast extending from the coastline to depths that do not exceed 200 meters. Its amplitude from the coast varies from a few meters to hundreds of kilometers.	https://definicion.de/plataforma-continental/
24	Fishing zones	The FAO made the first technical division of fishing zones in 1946. This division evolved over the years; the final division was established in 1980. Good fisheries management requires a regulation of fishing zones to establish international control of the management of the seas.	Food and Agriculture Organization of the United Nations (FAO)
25	Reef area	A coral reef is an underwater structure made of calcium carbonate secreted by corals. It is a type of biotic reef formed by colonies of stony corals, which generally live in low-nutrient marine waters.	Sea Around Us -Fisheries, Ecosystem and Biodiversity

Table continues...

PN	Indicator	Definition	Source
26	Exclusive economic zone	The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to a specific legal regime. The relevant provisions of the convention on the subject govern the rights and jurisdiction of the coastal state and the rights and freedoms of other states.	United Nations Convention on the Law of the Sea
27	Perception of corruption	The Corruption Perceptions Index (CPI) is the leading international barometer of public sector corruption, providing a comparative overview of corruption in 180 countries and territories. The index is based on thirteen data sources consisting of expert assessments from the private sector social sciences.	Transparency International
28	Global terrorism	The Global Terrorism Index (GTI) attempts to rank the world's nations according to the terrorist activity occurring in them. The list combines several factors associated with terrorist attacks to build an explicit picture of their impact over ten years, showing trends and providing a range of data to analyze.	National Consortium for the Study of Terrorism and Responses to Terrorism (START)
29	Fragility of the State	The Fund for Peace's Fragile States Index is a critical tool for highlighting both the states' normal pressures and identifying when these pressures push a state towards the brink of failure. By highlighting pertinent problems in weak and failed states, the index, the social science framework, and the software application on which it is built make a political risk assessment and conflict early warning accessible to policymakers and the general public.	The Fund for Peace (FFP)
30	Poverty and inequality	In 2020, Global extreme poverty was projected to increase for the first time in more than 20 years due to the COVID-19 pandemic's turmoil, exacerbated by the forces of conflict and climate change, already slowing progress in poverty reduction.	World Bank

Table continues...

PN	Indicator	Definition	Source
31	Marine pollution	A marine pollution offense is an illegal action resulting in the natural environment's pollution. Air pollution is an unlawful action that results in the pollution of the air. Water pollution is an unlawful action that results in the pollution of a body of water or water services. Soil pollution is an unlawful action that results in the pollution of soil.	United Nations Office on Drugs and Crime (UNODC)
32	Global peace (Pt)	This is an indicator that measures the level of peace in a country or region. It is prepared by the Institute for Economics and Peace with an international panel of peace institutes and think tank experts, and the University of Sydney's Centre for Peace and Conflict Studies, with data processed by the Intelligence Unit of Britain's weekly The Economist.	Institute for Economics and Peace
33	Internal and police security (Sc)	WISPI has been created to go beyond existing violence or peace measures as an international index to measure world police institutions' capacity to provide security services to societies and achieve the safety of their members. WISPI focuses on the delivery of security services and the outcome of the services provided. WISPI is considered the first international index to measure global domestic security indicators, rank countries according to their ability to provide security services and improve overall security performance.	World Internal Security & Police Index (WISPI)

Annex II. Conceptual model validity

Validity test of the proposed approach

Upon establishing the indicators, all the proposed definitions underwent a validity test to determine the proposed theoretical model's acceptance of degree. The validation method selected was the "Rank Ratio Coefficient by Expert Judgment." Five Ph.d. specialists in National Security and Maritime Power[1], researching Maritime Security, were asked to assess each concept using the following indicators: "adequate" (Value 3), "requires adjustments" (Value 2), or "inadequate" (Value 1).

Once their answers and comments were submitted, each concept's mean was obtained and divided into three. The concept was accepted if its final value was above 0.6; any below this value was rejected. The results yielded a validity index of 0.84 from the selected experts' opinion, which is within the ranges necessary in the social sciences to be accepted.

Application of the survey on national maritime development in Mexico

Once the indicators of the national maritime development measurement model were identified and their validity determined by the expert judgment method, a survey was developed to obtain two fundamental results:

1. Confirm the validity of each indicator within the model, previously assessed by the experts.
2. Determine the level of acceptance of each indicator in the community of naval captains and admirals belonging to the Mexican Navy.

A two-section survey was constructed for this purpose. The first one had five questions with Likert scale response options. The second had 120 questions (2 for each indicator). Their level of relevance was selected within the model and weighted against the other indicators.

The selected population was personnel from the Secretariat of the Mexican Navy, the Secretariat of National Defense, and civilian personnel. A non-probabilistic random scheme was used to create the sample, using the following sampling criteria:

1 The experts selected were five specialists with doctoral degrees, currently carrying out research on National Security in the United States (1), Colombia (1), Mexico (2), and the United Kingdom (1).

1. Completed postgraduate studies in National Security.
2. Currently pursuing a Doctorate in Defense and National Security, Maritime and Port Administration, or a Master's Degree in National Security.
3. Professor at a postgraduate level in National Security.

A sample of 27 individuals was collected using the established sampling criteria. It provided 3,375 data that were evaluated in the IBM SPSS® statistical software, yielding the following results:

Sixty-three percent of those surveyed considered Maritime Security "moderately adequate," making conceptual adjustments necessary. The rest of the indicators obtained results above 80% acceptance; therefore, requiring no modifications. The model was operationalized in Excel to continue obtaining the corresponding values.