



**Asociación  
Camino**s

**ASOCIACIÓN DE INGENIEROS DE CAMINOS,  
CANALES Y PUERTOS Y DE LA INGENIERÍA CIVIL**

**INFRASTRUCTURE REPORT CARD OF SPAIN**

**METHODOLOGY AND PROCEDURE MANUAL**

August, 2023



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### Acronym

ASOCIACIÓN CAMINOS	ASOCIACION DE INGENIEROS DE CAMINOS, CANALES Y PUERTOS Y DE LA INGENIERÍA CIVIL
ASCE	AMERICAN SOCIETY OF CIVIL ENGINEERS
EC	EUROPEAN COMMISSION
ICCP	INGENIEROS DE CAMINOS, CANALES Y PUERTOS
IRC	INFRASTRUCTURE REPORT CARD
OECD	ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
WB	THE WORLD BANK
WEF	WORLD ECONOMIC FORUM
GCI	GLOBAL COMPETITIVENESS INDEX
LPI	LOGISTIC PERFORMANCE INDEX

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## 1. Introduction and Background

Large public works and the services they provide are assets that societies need to satisfy and improve the quality of life of their citizens. Public works are essential for economic and social development: they form the basic infrastructure for the transportation of people and goods, enable the capture, distribution, and purification of water, and provide other essential services and goods such as energy and telecommunications. Public administrations must ensure the adequate provision of public works that are essential for society, their efficient management, and proper maintenance and operation; for this purpose, it is necessary to make the appropriate investments that meet social demands.

It is timely and appropriate to make it clear to society as a whole, to public administrations, and to governments that it is essential to have an adequate provision of public works, the need for efficient management, and the importance of operating, preserving, and maintaining them in suitable conditions.

Aware of these facts, in various countries, professional engineering organizations and major international bodies and institutions periodically produce specific reports that assess large public works and compare results between different countries. These reports are called "Infrastructure Report Cards" (IRC). They are prepared objectively, with verified information and solid and reliable databases, which allow informing society about the state of its public works and their most significant aspects.

Professional engineering organizations are well-positioned to produce these types of reports, as they bring together professionals and experts who work on public works, possess extensive experience and knowledge, and can provide objective information and mediate between civil society and governments. Additionally, professional organizations have greater access to the knowledge and experience of experts.

Numerous countries have been conducting such evaluations periodically, including the United States, the United Kingdom, Canada, Japan, New Zealand, Australia, South Africa, and Spain.

The objectives sought to be achieved are common, and the most important ones include:

- Inform society, and especially stakeholders, in an easily understandable manner about the status of major public works.
- Enable decision-making based on objective data.
- Facilitate the necessary actions to address identified shortcomings.
- Identify potential threats and opportunities arising from unmet needs.

Due to the long maturation period of public works, their status typically doesn't change significantly in short periods of time (in the absence of catastrophic events); therefore, evaluations are usually conducted every four years.

Taking into account the arguments presented, the Board of Directors of the Asociación de Ingenieros de Caminos, Canales y Puertos y de la Ingeniería Civil (Asociación Caminos), which took office on January 22, 2020, for a four-year term, established one of its objectives for this period as the update of the report on the state of public works in Spain. This report was previously prepared by the prior Board of Directors to compare the state of public works in Spain with that of other countries, analyze its development and evolution every four years, and derive global and specific conclusions for different sectors of public works.



## 2. Object and scope

The purpose of this document is to present the methodology and procedures manual used by the Asociación Caminos to assess public infrastructure in Spain.

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## 3. Methodology

### 3.1. General aspects

The absence of a publicly expressed methodology in infrastructure rating reports presented by engineering associations from various countries and international organizations, coupled with the difficulty of extrapolating such methodology to other countries, is the reason why Asociación Caminos decided to develop its own methodology and make it public.

However, after analyzing the most relevant international reports evaluating the state of public infrastructure in various countries, Asociación Caminos chose to take into consideration the report "Report Card for America's Infrastructure", published every four years by the American Society of Civil Engineers (ASCE) in the United States. The latest version is from the year 2021<sup>1</sup>.

The methodology presented by Asociación Caminos is based on one hand, on the analysis of the methodology used by ASCE in the mentioned report and, on the other hand, on the knowledge and contributions of experts and professional technicians in various sectors of public infrastructure in Spain who participate in the preparation of sector-specific reports.

The methodology includes an objective evaluation based on the analysis of quantitative indicators, both from Spain and from selected countries within our economic context, referenced to the most representative data for each sector in an international context. It also includes a qualitative evaluation of public infrastructure in Spain based on the opinions of a selected group of experts for each sector chosen by Asociación Caminos.

The methodology is designed to be applied to any time period and contains an assessment system that allows for the analysis of the evolution - initially every four years - of a set of objective indicators, while also considering expert opinions.

The results are comparable with those obtained by other countries and international organizations for the purpose of comparison. The methodology used is open to revision and the incorporation of expert suggestions.

The report on the state of Spanish public infrastructure includes a panel of over 200 experts and professionals who have collaborated in the drafting of the analysis for the six sectors of public infrastructure engineering studied.

In both the first edition in 2019 and the current version of 2023, the state of public infrastructure is examined in the following six sectors:

- Roads
- Railways
- Ports
- Airports
- Complete Water Cycle
- Urban and Metropolitan Public Transportation

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<sup>1</sup> [America's Infrastructure Report Card 2021 | GPA: C-](#)



The reports prepared by Asociación Caminos are intended to be used as international references. To achieve this, the information provided is rigorously and meticulously processed, and the methodology used is made public so that experts can evaluate the procedure and provide constructive criticism to enhance and improve the process in subsequent editions. Furthermore, the methodology allows it to be utilized by other international experts who can assess public works and services in their respective countries using similar criteria, thus producing comparable reports that facilitate a more comprehensive international comparative study.

The data used in the indicators have been published and come from various reliable sources, both public and private, as well as the knowledge of highly qualified experts in various sectors.

For the quantitative comparison of indicators among different analyzed countries, international databases with the same measurement criteria have been preferred. Additionally, these databases allow for the analysis of indicator trends in these countries over a specified period. The databases used for the preparation of the reports are publicly accessible and referenced to indicate their sources and the criteria employed.

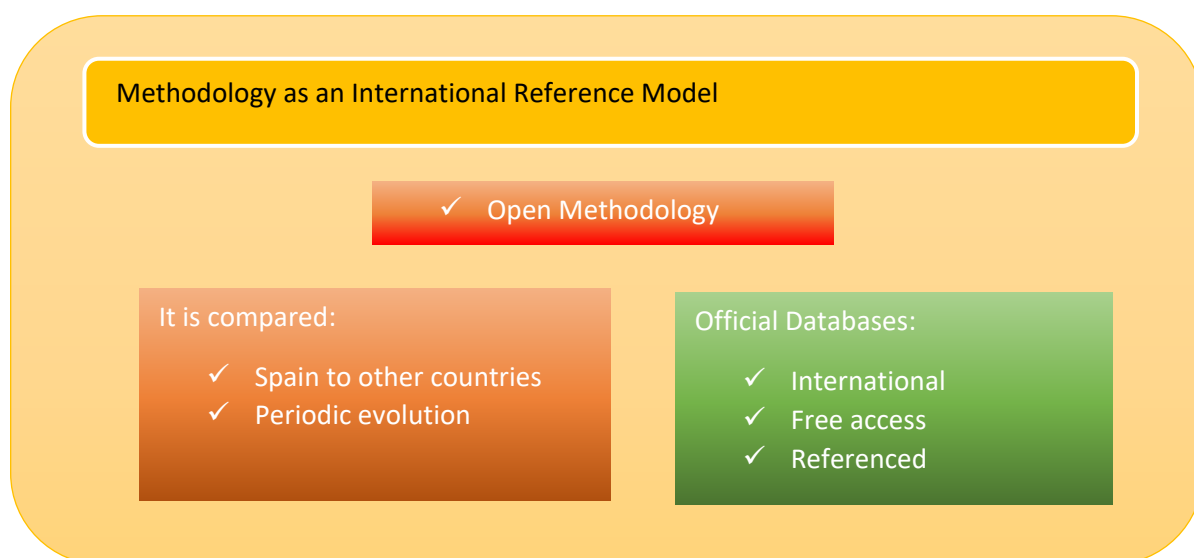


Figure 1: Methodological Criteria

### 3.2. Evaluation of Public Infrastructure Sectors

To facilitate the assessment, the analysis is grouped into eight sets of common characteristics for all sectors, although with specific features for each sector, called "Criteria". In this second edition, it has been deemed necessary to consolidate all environmental analysis within the "Future Adaptation" Criterion, which is now renamed "Future Adaptation and Sustainability". There has also been a recognized need to delve into aspects related to engineering, such as the investment allocated to infrastructure design and its adequacy to achieve the required quality. To address this, this analysis is grouped with the innovation criterion, which is now referred to as "Engineering and Innovation".





Figure 2: Groups of common characteristics (Criteria) used by Asociación Caminos for the assessment of public infrastructure sectors

The analysis through objective indicators and the evaluation of the questionnaire answered by experts aim to address the following questions (based on the ASCE report) for each Criterion in the sectors:

- **Capacity:** Does the provision and capacity of the public infrastructure sector meet current demands?
- **Performance:** Are the performance and current physical conditions of the public infrastructure sector adequate to meet current user expectations?
- **Funding:** How much investment is allocated to the funding of the public infrastructure sector?
- **Future Adaptation and Sustainability:** Is the capacity and performance of the public infrastructure sector prepared to meet future expectations and demands? Are the resources and investment considered adequate to address the future needs of the sector? How are actions being implemented to ensure environmental sustainability? Are active measures being taken to meet established goals for decarbonizing public infrastructure and transportation?
- **Operation and Maintenance:** Is the public infrastructure sector being operated and maintained in accordance with its needs? Is the necessary investment being made to ensure proper conservation and maintenance?
- **Safety:** Is the public infrastructure sector safe for users? Are effective measures in place to ensure safe performance and operation?
- **Resilience:** When threats and adverse incidents occur, what is the public infrastructure's capacity to prevent, protect, and minimize consequences for users, the environment, the economy, and national security? Is the public infrastructure prepared to recover to its initial state in a reasonable time once the threat or adverse incident has ceased? Are there alternatives to provide the service it offers?
- **Engineering and Innovation:** Are the resources allocated to engineering in the design, construction, conservation, management, and operation of the public infrastructure sector adequate? Is the investment in innovation adequate? What new techniques, materials, technologies, and operational methods are being implemented to improve public infrastructure? Is there progress in digitization, monitoring, and sensorization throughout the entire life cycle of public works? Is the information provided to users adequate?

The evaluation of each of these Criteria for each sector is characterized by an index called the "Criterion Index" or "Indicator of the Criterion", whose rating is determined by a combination of objective

indicators (referred to as "Indicators"). These Indicators are obtained after analyzing and assessing various ratios related to each Criterion in the public infrastructure sector. Additionally, there is a qualitative assessment of each Criterion carried out by experts and professionals in the sector who collaborate with Asociación Caminos through specific surveys/questionnaires.

These Criterion Indicators (or simply "Indicators") provide quantitative information based on objective data and characterize specific partial aspects of the public infrastructure sector. They can also be compared with those provided by other national and international organizations. These indicators are designed to yield consistent results regardless of who performs the assessment. Therefore, the essential conditions used to define these Indicators include:

- **Representativeness:** They must be explicit and representative, closely related to the element they intend to assess.
- **Repeatability:** They need to be available for multiple years.
- **Reproducibility:** They can be produced by different technicians with similar results.
- **Sensitivity:** They must be able to capture the changes they intend to assess.
- **Simplicity:** They should be easy to create and understand.

The process of defining these Indicators begins by establishing ratios that meet the aforementioned conditions for each Criterion in each sector. This involves using verified and referenced national and international databases.

These Indicators are applied to Spain and a set of countries selected for their proximity to our economic and social environment.

Because the range of each Indicator is highly dispersed and various scales adapted to each Indicator are used, the next step involves analyzing the obtained ratios and the causes of their dispersion. It is determined which countries require adjustment due to factors that do not provide an accurate representation of the assessment of this Criterion<sup>2</sup>, and these countries are adjusted using predefined parameters.

Subsequently, the value of each Indicator is compared with the help of experts to calibrate it on a scale from 0 to 10. This yields the value of each Indicator for Spain and each of the considered countries, allowing for a comparison of the assessments among different countries.

Since each Indicator's value results from an adjustment and transformation process of selected ratios to avoid excessive data dispersion (often due to topographical, territorial, economic, population distribution, etc., singularities) and to minimize the effect of occasional extreme data points, it is necessary to set upper and lower limits. Once the ratios are obtained, the dispersion of the values achieved in different countries and years is analyzed. To this end, for each Indicator, two methods have been considered to limit dispersion. The first method considers the mean and standard deviation of the data in the historical series, assigning as limit values the mean minus 1.5 times the standard deviation and the mean plus 1.5 times the standard deviation. The second method uses the percentile of the data in the historical series, analyzing the 90th or 80th percentile and the 10th percentile. The better method, considered more suitable for limiting dispersion, is adopted for each Indicator in each

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<sup>2</sup> For example, the topography of the country is a relevant criterion when determining the suitability of linear public works (such as roads, railways, etc.). Another example would be population density when assessing whether public works adequately cover the territory.



case. In some cases, there are exceptions to this general rule, such as the Safety Indicators, which are assigned a minimum value of zero, as it is considered the value that should receive the maximum rating.

Once these values are obtained, they are transformed on a scale from 0 to 10, with 10 being the highest value and 0 the lowest.

Finally, after obtaining all the Indicators for each Criterion, the Criterion Index is composed by assigning a certain weight to each Indicator based on its relative importance. Allocating these weights represents one of the greatest challenges, and the input of experts, who, based on their experience and knowledge, determine these weights, is essential.

It is important to note that, to form the Criterion Index as a weighted assessment of the Indicators, the maximum value that the Criterion Index can achieve is the result of the sum of the weight assigned to each Indicator multiplied by the maximum rating (10) that the Indicator can achieve, adjusted by a reduction coefficient (usually 90% of the maximum value). Applying this reduction coefficient is considered essential to balance the integration of the Indicators<sup>3</sup>.

Furthermore, because data from certain countries and years may not always be available, these missing data should not be considered or estimated to calculate the ratios. Data that cannot be verified or is considered erroneous is not taken into account in the assessment of the Criterion Indicator or the Sector Indicator. This way, the Criterion Index and the Sector Index only evaluate data for which there is effective evidence, although a method has been designed to prevent it from distorting the assessment of a particular country compared to other considered countries.

In essence, each country is assessed based on data that is genuinely considered reliable and verifiable, even though a different number of Indicators may have been used in the comparison with other countries. In any case, when this effect occurs, it is noted in the assessment of the Criteria and the Sector.

In general, a weighting is established among the quantitative indicators, not only within each Indicator but for each of the Criteria that determine the final assessment of the Sector.

As mentioned, in addition to the quantitative evaluation through objective indicators (obtained from a comparative assessment with other countries in our economic environment), to refine the assessment of public infrastructure sectors in Spain, a qualitative assessment is conducted based on the opinions of a selected group of experts for each sector.

Once the qualitative assessment has been processed, in the case of Spain, it is integrated with the quantitative assessment to obtain the final assessment of each Sector in Spain in the following proportions<sup>4</sup>:

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<sup>3</sup> For example, in the "Adaptation to the Future and Sustainability" criterion for the Roads sector, ratios of investment growth in relation to the growth of motorization rates, traffic, and population are analyzed. If the motorization rate decreases due to the expansion of shared-use vehicles, it would lower the sector's indicator even if traffic increases.

<sup>4</sup> In some sectors, there is a consideration of the possibility of changing this weighting due to the difficulty of having quantitative indicators accurately reflect the reality of the sector.

A. Quantitative assessment of each criterion by indicators... 50%

B. Qualitative assessment of each criterion by experts through surveys, questionnaires, and opinions... 50%

The final weighted result for each Country Criterion is determined by the Criterion Index, numerically defined on a scale from 0 to 10. In this scale, the maximum value (10) corresponds to an Excellent rating, while the minimum value (0) corresponds to a Very Poor rating.

To assess the state of various public infrastructure sectors in each country, an index called the Sector Index is used, which results from the weighting of the Criteria.

Both the Sector Index and the Criterion Index are graded on a scale of 0 to 10 and are evaluated using letter grades (A, B, C, D, E, FX, F) following both the European ETCS (European Credit Transfer and Accumulation System) system and the systems used in Anglo-Saxon countries.

ESPAÑA	0,0 a 2,9	3,0 a 4,9	5,0 a 5,9	6,0 a 6,9	7,0 a 7,9	8,0 a 8,9	9,0 a 10
	SUSPENSO		APROBADO		NOTABLE		SOBRESALIENTE
ECTS	FAIL	FAIL	SUFFICIENT	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT
	F	FX	E	D	C	B	A
ASOCIACIÓN CAMINOS	MUY INSUFICIENTE	INSUFICIENTE	SUFICIENTE	SUFICIENTE ALTO	BIEN	MUY BIEN	EXCELENTE
	F	FX	E	D	C	B	A
INFORME ASCE	CRITICAL	FAILING	POOR		MEDIOCRE	GOOD	EXCEPTIONAL
	1 (F)	2 (F)	3 (D)		4 (C)	4 (B)	5 (A)
GPA EEUU 1	F		C B-	B	B+		A
GPA EEUU 2	F		D- D	D+ C-	C C+	B- B	B+ A- A

Table 1: Translation: Equivalence between the ECTS system (European), the ASCE system (USA), and Asociación Caminos system

In a schematic way, the assessment process for each sector is as follows:

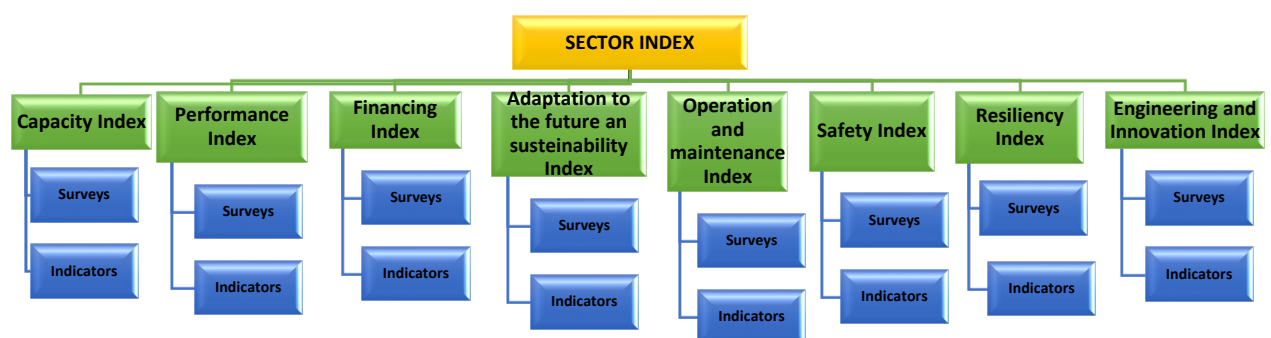


Figure 3: Scheme of the public works sectors assessment system

Once these Criterion Indexes are obtained for each sector, a specific document is prepared for each sector containing the Sector Indexes, which reflects the assessment of the public works sector in Spain and its comparison with the selected countries. Subsequently, in a new document, the overall public works in Spain are assessed, comparing them with other countries in our economic and social environment.

The reports also include a proposal for future investments in each public works sector in Spain that are considered necessary for each analyzed sector. The cost-benefit of this investment is described and, whenever possible, quantified.

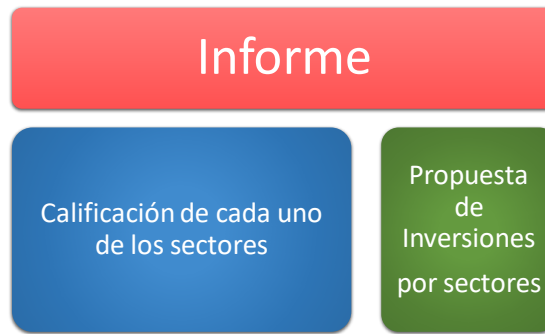
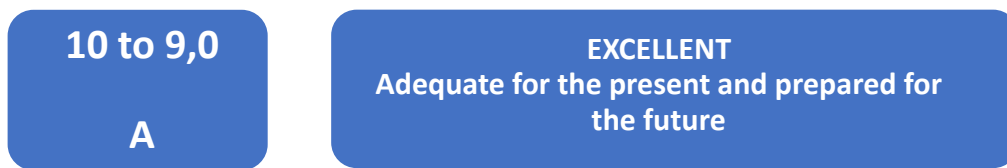


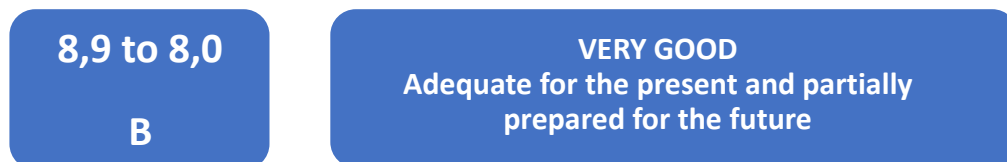
Figure 4: Content of the Asociación Caminos Report

The main characteristics of the public works sector assessment scale are as follows:



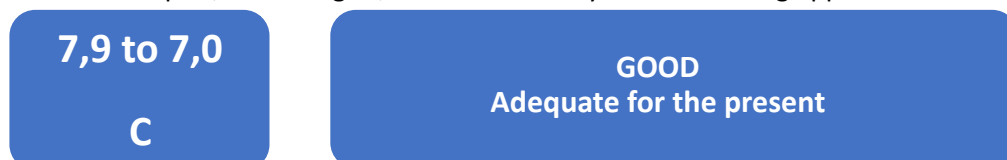
The public works sector is, in general terms, in excellent condition and is prepared to meet future demands:

- It is recently constructed or rehabilitated, and its state of conservation is very good.
- Very few elements of public works and equipment show signs of deterioration and require attention.
- It is equipped with modern standards and has good performance.
- It is safe for users and respects the environment.
- It is prepared to address threats and adverse incidents.
- New techniques, technologies, and innovative systems are being applied.



The public works sector is, in general terms, in good condition and is relatively well-prepared to meet future demands:

- It was constructed or rehabilitated a few years ago, and its state of conservation is good.
- Some elements of public works and equipment show signs of deterioration and require attention.
- It is equipped with modern standards and has good capacity and performance.
- It is safe for users and respects the environment.
- It is relatively well-prepared to address threats and adverse incidents.
- New techniques, technologies, and innovative systems are being applied.





The public works sector is, in general terms, in good condition but requires some improvements to be prepared for the future:

- Some elements of public works and equipment show signs of deterioration and require attention.
- Few elements of public works and equipment have significant deficiencies.
- It is relatively safe for users.
- It has some capacity and performance issues.
- It is not fully prepared to address threats or adverse incidents.

6,9 to 6,0

D

**HIGHLY SUFFICIENT**  
Requires some improvements

The public works sector is in acceptable conditions but faces some challenges in meeting current demands:

- Some elements of public works and equipment have deficiencies and require improvement actions.
- Safety of public works for users has some deficiencies and requires action.
- It has some capacity and performance issues.
- It is not well-prepared to address threats or adverse incidents

5,9 to 5,0

E

**SUFFICIENT**  
Requires important improvements

The public works sector is in sufficient but stringent conditions to meet current and future demand:

- Some elements of public works and equipment have significant deficiencies and require evident improvement actions.
- The safety of public works for users may have some deficiencies and requires actions.
- It has some capacity and performance issues.
- It is not well-prepared to address threats or adverse incidents.

4,9 to 3,0

FX

**INSUFFICIENT**  
At risk, requires immediate improvements

The public works sector is in poor condition and does not meet established standards:



- It is not capable of meeting current or future demand.
- Many elements of public works and equipment have significant deficiencies and require urgent improvement actions.
- Safety of public works for users has major deficiencies and requires actions.
- It frequently experiences capacity and performance issues.
- It is at risk in addressing threats or adverse incidents.

2,9 to 0,0

F

**VERY INSUFFICIENT**

**Has severe deficiencies**

The public works sector is in unacceptable conditions and cannot meet current demand:

- Most elements of public works and equipment have serious deficiencies and require extensive rehabilitation and improvement.
- Safety of public works for users has serious deficiencies.
- It has severe capacity and performance problems.
- Some elements of the public works sector are close to collapse and are unsuitable for use.



## 4. Global Indicators from International Organizations

International organizations and national engineering associations from various countries (such as the United States, the United Kingdom, Canada, Australia, Zambia, or South Africa) periodically release reports to assess the state of public works in their respective countries. These reports, known as Infrastructure Report Cards (IRCs), provide an overall assessment of public works, each with its own rating resulting from the independent evaluation of a limited number of sectors related to public works.

Generally, the rating for each sector is obtained by analyzing specific relevant criteria for that sector, such as investment, safety, facilities and equipment, the condition of public works, and more. These reports often include recommendations to improve the quality of public works, and in the case of the U.S. report, it is complemented by an economic proposal to address future needs.

The preparation of these reports typically relies on national data, international data, expert opinions, and the analysis of survey results targeting professionals in the various sectors under study. Sometimes, as in the case of Australia or the United Kingdom, the study is localized for different regions.

COUNTRY	IRC	Years first and last IRC	SECTORS	RATING SYSTEM	CRITERIA	MONEY QUANTIFICATION	RECOMENDATIONS
USA	6	1998-2017	16	GRADES ABCDF	8	YES	YES
AUSTRALIA	4	1999-2010	11	GRADES ABCDF	1	NO	YES
SOUTH AFRICA	3	2006-2017	11	GRADES ABCDE	4	NO	YES
UNITED KINGDOM	2	2010-2014	6	GRADES ABCDE	6	NO	YES
CANADA	2	2012-2016	8	5 Levels: from Very good to Very poor	3	NO	GENERALIST
ZAMBIA	1	2012	13	GRADES ABCDF	4	NO	GENERALIST

Table 2: Summaries reports IRC

COUNTRY	YEAR LAST REPORT	GENERAL RATING OF PUBLIC WORKS
USA	2017	D+
AUSTRALIA	2010	C+
SOUTH AFRICA	2017	D+
UNITED KINGDOM	2014	NOT RATED
CANADA	2016	NOT RATED
ZAMBIA	2012	NOT RATED

Table 3: Ratings last report IRC



The most relevant international global reports are: the "Report Card for America's Infrastructure"<sup>5</sup> produced by the American Society of Civil Engineers (ASCE) in the United States every four years, and reports from international organizations such as the Logistics Performance Index (LPI) from the World Bank and the Global Competitiveness Index (GCI) from the World Economic Forum. These reports incorporate indicators related to various sectors and consider the level of development in each country.

Unlike the World Bank and the World Economic Forum, there are other international organizations such as the OECD-International Transport Forum or EUROSTAT that do not provide a global rating for public works as a whole or for a specific sector. Instead, they quantify a series of indicators associated with the sector under study in different categories (public works, transportation, safety, etc.). These indicators provide a knowledge base that is useful for selecting the most representative ones and can be used as quantitative indices for different states assessing the sector.

#### 4.1.1. ASCE Report

The "Report Card for America's Infrastructure" by ASCE exclusively focuses on the United States for evaluation, without conducting comparative studies with other countries or describing the specific methodology used. However, it is primarily based on objective data and surveys of professionals within the association. The established indicators are not disclosed, but the report provides general results with a quantitative assessment that allows conclusions to be drawn about whether public infrastructure in the United States has improved or deteriorated in comparison to the previous four-year period.

The ASCE's Infrastructure Report Card for the United States analyzes eight criteria: capacity, physical condition, funding, future needs, operation and maintenance, public safety, resilience, and innovation.



Figure 5: Sectors Criteria. IRC Report, ASCE 2017

#### 4.1.2. The World Bank. LPI Index

The World Bank Group establishes the "Logistic Performance Index" (LPI), which is a comparative assessment tool for commercial logistics among 160 countries. The analysis of the results from the

<sup>5</sup> <https://www.infrastructurereportcard.org/>

latest edition of the study is documented in the report "Connecting to Compete 2018: Trade Logistics in the Global Economy".

The methodology is based on a global survey of on-the-ground operators with a standardized questionnaire divided into two parts, international and national. It utilizes standard statistical techniques to aggregate the data into a single LPI index that can be used for country comparisons.

#### 4.1.3. World Economic Forum – GCI Index

The World Economic Forum (WEF) has a group of experts who produce a series of annual economic reports. Among them, the report "The Global Competitiveness Report (2017–2018)" analyzes countries with data from the year 2016, creating a list of indicators and a main index called the Global Competitiveness Index (GCI).

This global competitiveness index combines 114 components grouped into twelve policy domains (pillars) that measure different aspects of competitiveness through individual indicators. It classifies them into three main categories (sub-indices) where each category is critical for a particular stage of development for each of the 137 participating countries.

The main categories are:

- S 1: Basic Requirements
- S 2: Efficiency Enhancers
- S 3: Innovation and Complexity Factors

## 5. Global indicators from national organizations

In Spain, there is a fundamental organization that provides data on the public works sectors:

- Ministry of Public Works: Transport and Logistics Observatory of Spain

Website:

[http://observatoriotransporte.fomento.es/OTLE/LANG\\_CASTELLANO/](http://observatoriotransporte.fomento.es/OTLE/LANG_CASTELLANO/)

The Transport and Logistics Observatory of Spain contains data and indicators from the following sources:

- Indicators
- Databases
- Annual Statistical Yearbooks

Los indicadores están clasificados por tipos, y por cada uno se elabora una ficha:



Figure 6: Classification of Indicators by the Ministry of Public Works

The Observatory of Transport and Logistics in Spain provides indicators for the analyzed sectors.

## 6. Sectorial Indicators for Airports

### 6.1. International Indicators for Airports

For the airport sector, indicators from the following international organizations have been analyzed:

- OECD-International Transport Forum
- EUROSTAT
- ACI
- Flight Safety Foundation
- SKYTRAX

These international organizations, used as references, also have supplementary databases that allow the creation of new quantitative indices. The selected data, along with data from databases of various countries, have been used in the analysis.

### 6.2. National Indicators for Airports

In Spain, there are two fundamental organizations that provide airport data:

- Ministry of Public Works: Observatory of Transport and Logistics in Spain

Website:

[http://observatoriotransporte.fomento.es/OTLE/LANG\\_CASTELLANO/](http://observatoriotransporte.fomento.es/OTLE/LANG_CASTELLANO/)

- AENA

Website:

<http://www.aena.es/>

### 6.3. Indicators Used for the Evaluation of Airports

For the preparation of the report on the airport sector, the following indicators were used:



AIRPORTS INDICATORS. 2023	
<b>1 CAPACITY</b>	
AERO C.1	Total passengers transported - arrivals and departures - (Millions of passengers) (EU+WORLD)
AERO C.2	Total passengers transported - arrivals and departures - (Millions of passengers) / Real GDP (\$) (EU+WORLD)
AERO C.3	Total air cargo and mail transported (t) (EU+WORLD)
AERO C.4	Total air cargo and mail transported (t) / Population (EU+WORLD)
AERO C.5	Number of airports / Millions of inhabitants
AERO C.6	Number of airports / Real GDP (\$)
AERO C.7	Total passengers transported - National and international aircraft of the country - (Millions of passengers) (WB)
AERO C.8	Available seat capacity for regular flights per thousand inhabitants (OECD)
AERO C.9	EU countries. Total passengers transported within the EU - arrivals and departures - (Millions of passengers) (EUROSTAT)
AERO C.10	10. EU countries. National air passenger transport within the EU (Millions of passengers) (EUROSTAT)
AERO C.11	EU countries. Intra-EU passengers transported - includes domestic flights - (Millions of passengers) (EUROSTAT)
AERO C.12	EU countries. Extra-EU passengers transported (Millions of passengers) (EUROSTAT)
AERO C.13	EU countries. Total air cargo and mail transport (t) (EUROSTAT)
AERO C.14	EU countries. Domestic air cargo and mail transport (t) (EUROSTAT)
AERO C.15	EU countries. International air cargo and mail transport (t) (EUROSTAT)
AERO C.16	EU countries. Number of commercial air flights (passengers, cargo, and mail) (Millions) (EUROSTAT)
<b>2 PERFORMANCE</b>	
AERO P.1	Global Logistics Performance Index (LPI) - WB
AERO P.2	Passenger traffic by nationalities of companies - international and domestic - (Millions of passenger-kilometers)
AERO P.3	Passenger traffic by nationalities of companies - international - (Millions of passenger-kilometers)
AERO P.4	Freight traffic (Millions of ton-kilometers) - WB
AERO P.5	Airport connectivity - GCI Score (WEF)
AERO P.6	Efficiency of Air Transport Services - GCI Score (WEF)
AERO P.7	EU countries. Passenger traffic transported (Millions of passenger-kilometers) - EUROSTAT
AERO P.8	EU countries. National and intra-EU27 international passenger traffic (Millions of passenger-kilometers) - EUROSTAT
AERO P.9	EU countries. Extra-EU27 international passenger traffic (Millions of passenger-kilometers) - EUROSTAT
AERO P.10	EU countries. National and international intra-EU27 merchandise traffic (Millions of ton-kilometers) - EUROSTAT
AERO P.11	EU countries. Extra-EU27 international merchandise traffic (Millions of ton-kilometers) - EUROSTAT
<b>3 FINANCING</b>	
AERO F.1	Investment in airports (Millions of €) / Transported passengers (Millions of passengers)
AERO F.2	Investment in airports (€) / Cargo (tonnes)
AERO F.3	% Investment in airports (€) / Real GDP (€)
AERO F.4	Investment in airports (€) / Inhabitants
AERO F.5	Air passenger transport per one thousand units of current GDP (USD)
AERO F.6	Air cargo transport in tonne-kilometers per one thousand units of current GDP (USD)
<b>4 ADAPTATION TO THE FUTURE AND SUSTAINABILITY</b>	
AERO A.1	Year-on-year cumulative growth index. Investment in airports / GDP (Index 100 in 2015)
AERO A.2	Year-on-year cumulative growth index. Investment in airports / (population + tourists) (Index 100 in 2015)
AERO A.3	Year-on-year cumulative growth index. Investment in airports / passengers (Index 100 in 2015)
AERO A.4	Year-on-year cumulative growth index. Investment in airports / cargo (Index 100 in 2015)
AERO A.5	Year-on-year cumulative growth index. Investment in airports / Departures of flights worldwide by companies registered in the country (Index 100 in 2015)
AERO A.6	Share of CO2 emissions from navigation in total CO2 emissions from transportation (OECD)
AERO A.7	Percentage of CO2 emissions from national aviation in total CO2 emissions from transportation (OECD)
AERO A.8	Proportion of CO2 emissions from international aviation bunkers in total CO2 emissions (OECD)
AERO A.9	Development of Climate Change Mitigation Technologies related to Transportation (OECD)
<b>5 OPERATION AND MAINTENANCE</b>	
AERO O.1	WB. Air Transport, Departures of flights worldwide by companies registered in the country (x 1000) / (Population + tourists)
AERO O.2	WB. Air Transport, Departures of flights worldwide by companies registered in the country (x1000000) / GDP (\$)
AERO O.3	EU. Number of Commercial Air Flights (passengers, cargo, and mail) (Mills. X 1000000) / GDP (\$)
AERO O.4	EU. Punctuality in minutes in departures from the most important airports (airports > 25 million passengers/year). Sep 2022
AERO O.5	EU. Punctuality in arrivals at the most important airports (airports > 25 million passengers/year). Sep 2022
AERO O.6	EU. Hub connectivity of the country's best airport (2022)
<b>6 SAFETY</b>	
AERO S.1	Fatalities in passenger flights
AERO S.2	Fatalities in accidents in commercial air transport
AERO S.3	Injuries in accidents in commercial air transport
AERO S.4	Fatalities from accidents in aerial works
AERO S.5	Injuries in accidents in airport works
<b>7 RESILIENCE</b>	
AERO R.1	Hub connectivity of the best airport in the country (2022) - EU
AERO R.2	Direct airport connectivity by country - Airport Council International Europe
AERO R.3	Indirect airport connectivity by country - Airport Council International Europe
AERO R.4	Connectivity as airports by country - Airport Council International Europe
<b>8 ENGINEERING AND INNOVATION</b>	
AERO I.1	Ranking position in Skytrax
AERO I.2	Number of patents. Aeronautics and Air Transport (OECD)
AERO I.3	% of GDP devoted to Gross Domestic Expenditure on Research and Development (OECD R&D)
AERO I.4	Gross Domestic Expenditure on Research and Development (\$)/Population (OECD R&D)
AERO I.5	% of GDP allocated to basic research expenditure (OECD R&D)
AERO I.6	% of GDP from private financing for Research and Development (OECD R&D)
AERO I.7	% of GDP from public financing for Research and Development (OECD R&D)
AERO I.8	Digitalization. Participation in new technologies. GCI Score (WEF)
AERO I.9	Digitalization. Index of Information and Communication Technology Infrastructure. (ND Index)
AERO I.10	Digitalization. % of people using the internet
AERO I.11	Engineering. Regulatory transparency. Index of services trade restrictiveness (OECD)
AERO I.12	Engineering. Barriers to competition. Index of services trade restrictiveness (OECD)
AERO I.13	Engineering. Restrictions on movement. Index of services trade restrictiveness (OECD)
AERO I.14	Engineering. Restrictions on entry of foreign engineers. Index of restrictiveness (OECD)
AERO I.15	Innovation Index. ND Gain Index

## 7. Sectorial indicators for Roads

### 7.1. International Indicators for Roads

For the road sector, indicators from the following international organizations have been analyzed:

- OECD-International Transport Forum. <https://www.itf-oecd.org/>
- EUROSTAT. [https://ec.europa.eu/info/departments/eurostat-european-statistics\\_es](https://ec.europa.eu/info/departments/eurostat-european-statistics_es)
- International Road Federation (IRF) <https://worldroadstatistics.org/>
- World Bank. <https://worldroadstatistics.org/>
- World Economic Forum <https://www.weforum.org/>
- European Commission [https://ec.europa.eu/commission/index\\_es](https://ec.europa.eu/commission/index_es)
- International Energy Agency <https://www.iea.org/>
- Federal Highway Administration (FHWA) de EEUU <https://www.fhwa.dot.gov/>
- American Society of Civil Engineers. <https://www.fhwa.dot.gov/>

These international organizations, which have been used as references, also have supplementary databases that allow the creation of new quantitative indices. These fundamental data, carefully selected, along with data from various countries' databases, have been the primary source of information for constructing road indicators.

### 7.2. National Indicators for Roads

In Spain, there are several essential organizations that provide data on roads:

- Ministry of Public Works:
  - Observatory of Transport and Logistics in Spain

[http://observatoriotransporte.fomento.es/OTLE/LANG\\_CASTELLANO/](http://observatoriotransporte.fomento.es/OTLE/LANG_CASTELLANO/)

- Statistical Yearbook:

<https://www.fomento.gob.es/informacion-para-el-ciudadano/informacion-estadistica/anuario-estadisticas-de-sintesis-y-boletin/anuario-estadistico>

- Ministry of the Interior:
  - Statistical Yearbook of Accidents:

<http://www.dgt.es/es/seguridad-vial/estadisticas-e-indicadores/publicaciones/anuario-estadistico-accidentes/>

- Ministry for the Ecological Transition:
  - Guide for the Preparation of Physical Environment Studies: Content and Methodology.

### 7.3. Indicators Used for the Evaluation of Roads

For the preparation of the report on the road sector, the following indicators have been used:



ROADS INDICATORS 2023	
<b>1 CAPACITY</b>	
CRR C.1	km of roads / 1,000 inhabitants
CRR C.2	km of interurban roads / 1,000 inhabitants
CRR C.3	km of high-capacity roads / 1,000 inhabitants
CRR C.4	km of roads / country's area (km <sup>2</sup> )
CRR C.5	km of interurban roads / country's area (km <sup>2</sup> )
CRR C.6	km of high-capacity roads / country's area (km <sup>2</sup> )
CRR C.7	km of equivalent high-capacity roads / country's area (km <sup>2</sup> )
CRR C.8	km of high-capacity roads / population density
<b>2 PERFORMANCE</b>	
CRR P.1	Total Vehicle Fleet / 1,000 inhabitants
CRR P.2	Total Vehicle Fleet / km of roads
CRR P.3	Total Vehicle Fleet / km of high-capacity roads
CRR P.4	Total Vehicle Fleet / km of interurban roads
CRR P.5	km of High-Capacity Roads / km of Interurban Roads
CRR P.6	Interior Passenger Traffic by Road (10 <sup>6</sup> Passenger-km) / km of interurban roads
CRR P.7	Interior Freight Traffic by Road (10 <sup>6</sup> ton-km) / km of interurban roads
CRR P.8	Route Factor (Road Distance / Direct Distance)
CRR P.9	Annual Hours of Congestion on Roads
CRR P.10	Road Connectivity. GCI Score (WEF)
CRR P.11	Quality of Road Infrastructure. GCI Score (WEF)
<b>3 FINANCING</b>	
CRR F.1	% Investment in Roads / National GDP
CRR F.2	Investment in Roads / Inhabitants (current €)
CRR F.3	Investment in Roads / km of roads (current €)
CRR F.4	Investment in Roads / Vehicle Fleet (current €)
CRR F.5	Investment in Roads / Country Area (km <sup>2</sup> ) (current €)
CRR F.6	Investment in Roads / km of high-capacity roads
CRR F.7	Investment in Roads / Interior Passenger Traffic by Road (10 <sup>6</sup> Passenger-km)
CRR F.8	Investment in Roads / Interior Freight Traffic by Road (10 <sup>6</sup> ton-km)
CRR F.9	Investment in Roads / Total Investment in Land Transport Infrastructure
<b>4 FUTURE ADAPTATION AND SUSTAINABILITY</b>	
CRR A.1	Cumulative Year-on-Year Growth Index. Investment in Roads / Motorization Rate (Index 100 in 2015)
CRR A.2	Cumulative Year-on-Year Growth Index. Investment in Roads / GDP (Index 100 in 2015)
CRR A.3	Cumulative Year-on-Year Growth Index. Investment in Roads / Interior Passenger Traffic by Road
CRR A.4	Cumulative Year-on-Year Growth Index. Investment in Roads / Interior Freight Traffic by Road
CRR A.5	Cumulative Year-on-Year Growth Index. Investment in Roads / Population (Index 100 in 2015)
CRR A.6	Greenhouse Gas Emission Growth Index from Transportation (t equivalent of CO <sub>2</sub> )
CRR A.7	% Electric and Plug-in Hybrid Vehicles / Light Vehicles Registered
CRR A.8	% of CO <sub>2</sub> Emission Generated by Road Transportation of Total Transportation
CRR A.9	CO <sub>2</sub> Emissions from Registered Light Vehicles (g/km)
CRR A.10	Charging Points for Electric Vehicles / Million Inhabitants
CRR A.11	% of Urban Area Population Exposed to High Noise Levels
CRR A.12	% of Renewable Energy in Total Energy Consumed in Transportation
CRR A.13	Development of Climate Change Mitigation Technologies related to Transportation (OECD)
<b>5 OPERATION AND MAINTENANCE</b>	
CRR O.1	O&M Investment / National GDP
CRR O.2	O&M Investment / Inhabitants
CRR O.3	O&M Investment / Equivalent Kilometers of Roads
CRR O.4	O&M Investment / Total Road Investment
CRR O.5	O&M Investment / Interior Passenger Traffic by Road (€/million passenger-km)
CRR O.6	O&M Investment / Interior Freight Traffic by Road (€/million tonne-km)
<b>6 SAFETY</b>	
CRR S.1	Accidents with casualties / 100,000 inhabitants
CRR S.2	Accidents with casualties / km of roads
CRR S.3	Fatalities / km of road
CRR S.4	Fatalities / 100,000 inhabitants
CRR S.5	Fatality rate (Number of fatalities / Number of casualties)
CRR S.6	Number of casualties / Interior passenger traffic by road (Million passenger-km)
CRR S.7	Fatalities / Interior passenger traffic by road (Million passenger-km)
<b>7 RESILIENCE</b>	
CRR R.1	Railway density / Road density
CRR R.2	km of roads / Country area (km <sup>2</sup> )
CRR R.3	Secondary road length / Main road length
CRR R.4	km of high-capacity roads / Country area (km <sup>2</sup> )
CRR R.5	Transport infrastructure quality. GCI Score (WEF)
<b>8 ENGINEERING AND INNOVATION</b>	
CRR I.1	% of GDP spent on Research and Development (R&D) (OECD R&D)
CRR I.2	Gross domestic expenditure on R&D (\$) / Population (OECD R&D)
CRR I.3	% of GDP allocated to basic research expenditure (OECD R&D)
CRR I.4	Total R&D personnel per 1,000 employees (OECD R&D)
CRR I.5	% of GDP for private funding of R&D (OECD R&D)
CRR I.6	% of GDP for public funding of R&D (OECD R&D)
CRR I.7	Digitalization. Participation in new technologies. GCI Score (WEF)
CRR I.8	Digitalization. Information and communication technology infrastructure index (ND Index)
CRR I.9	Digitalization. Number of internet users
CRR I.10	Resident patent applications (per million inhabitants)
CRR I.11	Engineering. Regulatory transparency. Index of trade in services restrictions (OECD)
CRR I.12	Engineering. Barriers to competition. Index of trade in services restrictions (OECD)
CRR I.13	Engineering. Movement restrictions. Index of trade in services restrictions (OECD)
CRR I.14	Engineering. Restrictions on the entry of foreign engineers
CRR I.15	Innovation Index. ND Gain Index
CRR I.16	Number of patents related to road transportation per million inhabitants (OECD)

## 8. Sectorial indicators for Complete Water Cycle

### 8.1. International Indicators for Complete Water Cycle

For the water cycle sector, the following international organizations' indicators have been analyzed:

- UN-Water
- OECD-International Transport Forum
- Eurostat
- IHME (Institute for Health Metrics and Evaluation)
- Confederation of Danish Industry

These international organizations also provide complementary databases that enable the creation of quantitative indices.

### 8.2. National Indicators for Complete Water Cycle

In Spain, there are two essential organizations that provide data for the water sector:

- The Ministry for the Ecological Transition (MITECO) provides relevant information on its website regarding the water sector, focusing on legislative matters, hydrological information, and an inventory of dams and reservoirs. Statistical data on existing dams and reservoirs in Spain, as well as water storage reserves, can also be consulted. The Ministry publishes a weekly hydrological bulletin. Regarding the inventory of dams and reservoirs, it is conducted and maintained in collaboration with the Spanish Committee on Large Dams (SPANCOLD), which, in turn, supplies statistical data to the International Commission on Large Dams (ICOLD), of which Spain is a member state through SPANCOLD.
- The Spanish Association of Water Supply and Sanitation (AEAS) is a private entity that has been conducting a biennial study on Drinking Water Supply and Sanitation in Spain since 1987, in collaboration with the Spanish Association of Companies Managing Water Services to Communities (AEAS).

### 8.3. Indicators Used for the Evaluation of Complete Water Cycle

For the preparation of the water cycle report, the following indicators have been used:





COMPLETE WATER CYCLE INDICATORS	
<b>1 CAPACITY</b>	
Water C.1	% of the population with access to basic drinking water services
Water C.2	% of the population with access to basic sanitation services
Water C.3	Water extracted for non-domestic use/irrigated area (m3/ha)
Water C.4	% Irrigated area/total area
Water C.5	(100-Water stress index)*available water per capita (m3)
Water C.6	% Irrigated area/agricultural land area
Water C.7	Water stress index (Water extracted from freshwater resources/(Renewable freshwater resources - Environmental flow) (%) (SDG: 6.4.2)
<b>2 PERFORMANCE</b>	
Water P.1	Percentage of population using safely managed drinking water services
Water P.2	Percentage of population using safely managed sanitation services
Water P.3	Water use efficiency (USD/m3)/(GDP*10,000) (SDG: 6.4.1) UN
Water P.4	Percentage of wastewater collected in sewer systems
Water P.5	% of population connected to a wastewater treatment plant - primary treatment - (OECD)
Water P.6	% of population connected to a wastewater treatment plant - secondary treatment - (OECD)
Water P.7	% of population connected to a wastewater treatment plant - tertiary treatment - (OECD)
<b>3 FINANCING</b>	
Water F.1	(Total Expenditure Water Cycle Sector / population)*Investment Needs
Water F.2	(Total Expenditure Water Cycle Sector / real GDP) * Investment Needs * 1,000,000
Water F.3	(Maintenance expenditure / Total expenditure) * Investment Needs
Water F.4	Total Expenditure Water Cycle Sector / population
Water F.5	Total Expenditure Water Cycle Sector / real GDP
Water F.6	Operation and maintenance expenditure / Total expenditure
Water F.7	Investment Needs
<b>4 Adaptation to the Future and Sustainability</b>	
Water A.1	Freshwater resources (long-term average) - Evapotranspiration - (m3/person) (OECD)
Water A.2	Freshwater resources (long-term average) - Total renewable per capita (m3/person) - (OECD)
Water A.3	Freshwater extraction (long-term average) (millions m3) - Gross extraction per capita (m3/person) - (OECD)
Water A.4	Projected change in annual runoff (ND-GAIN Water Index)
Water A.5	Projected change in annual groundwater recharge (ND-GAIN Water Index)
Water A.6	Fresh water withdrawal rate (ND-GAIN Water Index)
Water A.7	Water dependency ratio (ND-GAIN Water Index)
Water A.8	Dam capacity (ND-GAIN Water Index)
Water A.9	% Technologies related to water treatment and purification (OECD)
Water A.10	% Gross extraction of freshwater per capita / total renewable freshwater per capita
<b>5 OPERATION AND MAINTENANCE</b>	
Water O.1	Expenditure on water sector operation and maintenance / population
Water O.2	% Expenditure on water sector operation and maintenance / real GDP
Water O.3	Reliability of water supply. GCI Index (WEF)
<b>6 SECURITY</b>	
Water S.1	Premature deaths, per million inhabitants (unsafe water source) (OECD)
Water S.2	Premature deaths, per million inhabitants (Unsafe sanitation) (OECD)
Water S.3	Premature deaths, per million inhabitants (Lack of safe handwashing facilities) (OECD)
<b>7 RESILIENCE</b>	
Water R.1	Available water per capita (Renewable freshwater resources/Population) (m3/year)
Water R.2	(Renewable freshwater resources*(1-Water stress index))/agricultural land area (m3/ha)
Water R.3	% Integrated water resources management (SDG: 6.5.1)
Water R.4	% Annual freshwater extraction for domestic use/Total freshwater extraction
<b>8 ENGINEERING AND INNOVATION</b>	
Water I.1	Number of patents related to water treatment and purification per million population (OECD)
Water I.2	Number of patents related to water pollution reduction per million population (OECD)
Water I.3	Number of patents. Desalination of seawater per million population (OECD)
Water I.4	% of GDP allocated to Gross Domestic Expenditure on Research and Development (R&D) (OECD R&D)
Water I.5	Gross Domestic Expenditure on Research and Development (\$)/Population (OECD R&D)
Water I.6	% of GDP allocated to basic research expenditure (OECD R&D)
Water I.7	% of GDP of Private Funding for Research and Development (R&D) (OECD R&D)
Water I.8	% of GDP of Public Funding for Research and Development (R&D) (OECD R&D)
Water I.9	Digitization. Participation in new technologies. GCI Score (WEF)
Water I.10	Digitization. Information and Communication Technology Infrastructure Index. (ND Index)
Water I.11	Digitization. % of people using the internet
Water I.12	Engineering. Regulatory transparency. Services Trade Restrictiveness Index (OECD)
Water I.13	Engineering. Barriers to competition. Services Trade Restrictiveness Index (OECD)
Water I.14	Engineering. Movement restrictions. Services Trade Restrictiveness Index (OECD)
Water I.15	Engineering. Restrictions on entry of foreign engineers. Services Trade Restrictiveness Index (OECD)
Water I.16	Innovation index. ND Gain Index

## 9. Sectorial indicators for Railways

### 9.1. International Indicators for Railways

The most representative international organizations that provide data on the railway sector are:

- The World Bank
- World Economic Forum
- OECD- International Transport Forum
- EUROSTAT
- Union Internationale des Chemins de Fer (UIC)
- International Energy Agency (IEA)

### 9.2. National Indicators for Railways

In Spain, there are three fundamental organizations to provide railway data:

- Ministry of Public Works: Observatory of Transportation and Logistics in Spain

[http://observatoriotransporte.fomento.es/OTLE/LANG\\_CASTELLANO/](http://observatoriotransporte.fomento.es/OTLE/LANG_CASTELLANO/)

- Railway Foundation: Railway Observatory in Spain

[https://www.fomento.gob.es/MFOM/LANG\\_CASTELLANO/DIRECCIONES\\_GENERALES/TRANSPORTE TERRESTRE/OBSERVATORIOS/Observatorio\\_ferrocarril.htm](https://www.fomento.gob.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/TRANSPORTE_TERRESTRE/OBSERVATORIOS/Observatorio_ferrocarril.htm)

- Additional information can be obtained through ADIF, in the document "Network Declaration"

[http://www.adif.es/es\\_ES/conoceradif/declaracion\\_de\\_la\\_red.shtml](http://www.adif.es/es_ES/conoceradif/declaracion_de_la_red.shtml)

### 9.3. Indicators Used for the Evaluation of Railways

For the preparation of the Railway sector report, the following indicators have been used:



RAILWAYS INDICATORS 2023	
<b>1</b>	<b>CAPACITY</b>
C.1	Railway Lines (km) / 1,000 Inhabitants
C.2	Electrified Railway Lines (km) / 1,000 Inhabitants
C.3	High-Speed Railway Lines (km) (speed > 250 km/h) / 1,000 Inhabitants
C.4	Railway Lines (km) / Country Area (KM2)
C.5	Railway Lines (km) / Population Density
C.6	Number of Level Crossings / Railway Lines (km)
C.7	Number of Stations / km of Railway Lines
<b>2</b>	<b>PERFORMANCE</b>
P.1	High-Speed Railway Lines / Railway Lines
P.2	Electrified Railway Lines / Railway Lines
P.3	Length of Railway Tracks / Railway Lines
P.4	Domestic Passenger Traffic by Railway (10 <sup>6</sup> Passenger-km) / km of Railway Tracks
P.5	Domestic Freight Traffic by Railway (10 <sup>6</sup> ton-km) / km of Railway Lines
P.6	Percentage of Freight Transport in Railways in Total Land Freight Transport
P.7	Percentage of Passenger Transport in Railways in Total Land Passenger Transport
P.8	Infrastructure Quality and Trade Index. ND Gain Index
P.9	Railway Service Efficiency (WEF)
<b>3</b>	<b>FINANCING</b>
F.1	Percentage of Investment in Railways / National GDP (Current €)
F.2	Investment in Railways / Inhabitants (Current €/inhabitant)
F.3	Investment in Railways / km of Railway Lines (Current €/km)
F.4	Investment in Railways / Country Area (km2) (Current €/km2)
F.5	Investment in Railways / Domestic Passenger Traffic by Railway (10 <sup>6</sup> Passenger-km)
F.6	Investment in Railways / Domestic Freight Traffic by Railway (10 <sup>6</sup> ton-km)
F.7	Percentage of Investment in Railways / Total Investment in Land Transport Infrastructure
<b>4</b>	<b>Future Adaptation and Sustainability</b>
A.1	High-Speed Railway Lines with Speed > 160 km/h / Railway Lines
A.2	Level Crossings / Railway Lines
A.3	Percentage of Passenger-km by Rail / Passenger-km (Land)
A.4	Percentage of ton-km by Rail / ton-km (Land)
A.5	CO2 Emissions from Railways / Railway Lines (Thousands of t CO2 Equiv/km of Railway Lines)
A.6	Electrified Lines / km of Railway Lines
A.7	Percentage of Renewable Energy in Transport / Energy Consumed in Transport
A.8	Development of Climate Change Mitigation Technologies related to Transport (OCDE)
<b>5</b>	<b>Operation and Maintenance</b>
O.1	Investment in O&M / National GDP
O.2	Investment in O&M / Inhabitants
O.3	Investment in O&M / km of Railway Lines
O.4	Investment in O&M / Total Investment in Railways
O.5	Investment in O&M / Domestic Passenger Traffic (€)
O.6	Investment in O&M / Domestic Freight Traffic (€)
O.7	Operating Expenses / Number of Stations (€)
O.8	Operating Expenses / km of Railway Lines (€)
O.9	Operating Expenses / Population (€)
O.10	Operating Expenses / Million ton-km (€)
<b>6</b>	<b>Safety</b>
S.1	Number of Fatalities / 100 km of Railway Lines
S.2	Number of Fatalities / Million Population
S.3	Number of Fatalities / Passenger-km by Rail (hundred million passenger-km)
S.4	Number of Fatalities / Freight Traffic by Rail (hundred million ton-km)
S.5	Number of Accidents / 100 km of Railway Lines
<b>7</b>	<b>Resilience</b>
R.1	Number of Stations / Railway Lines
R.2	Number of Nodes / Number of Stations
R.3	Railway Density / Road Density
R.4	High-Speed Railway km / Country Area (KM2)
R.5	Transport Infrastructure. GCI Score (WEF)
<b>8</b>	<b>Engineering and Innovation</b>
I.1	Increase in High-Speed Lines / Railway Lines (2019/2015)
I.2	Innovation Index. ND Gain Index
I.3	Percentage of GDP spent on Gross Domestic Expenditure on R&D (OCDE R&D)
I.4	Gross Domestic Expenditure on R&D (\$) / Population (OCDE R&D)
I.5	Percentage of GDP spent on Basic Research (OCDE R&D)
I.6	Total R&D Personnel per 1,000 Employees (OCDE R&D)
I.7	Percentage of GDP for Private Funding for R&D (OCDE R&D)
I.8	Percentage of GDP for Public Funding for R&D (OCDE R&D)
I.9	Number of Railway Transport Patents / Million Inhabitants (OCDE)
I.10	Digitalization. Participation Percentage in New Technologies. GCI Score (WEF)
I.11	Digitalization. Index of Information and Communication Technology Infrastructures. ND Index
I.12	Digitalization. Percentage of Internet Users
I.13	Engineering. Regulatory Transparency. Trade in Services Restrictiveness Index (OCDE)
I.14	Engineering. Barriers to Competition. Trade in Services Restrictiveness Index (OCDE)
I.15	Engineering. Movement Restrictions. Trade in Services Restrictiveness Index (OCDE)
I.16	Engineering. Restrictions on Entry of Foreign Engineers. Trade in Services Restrictiveness Index (OCDE)

## 10. Sectorial indicators for Ports

### 10.1. International Indicators for Ports

For the port sector, indicators from the following international organizations have been analyzed:

- OECD-International Transport Forum
- EUROSTAT
- United Nations Conference on Trade and Development (UNCTAD)

These international organizations, which have been used as references, also have complementary databases that allow for the development of new quantitative indices.

### 10.2. National Indicators for Ports

In Spain, three fundamental organizations have been identified to provide data on the port sector:

- Ministry of Public Works: Transport and Logistics Observatory of Spain  
[http://observatoriotransporte.fomento.es/OTLE/LANG\\_CASTELLANO/](http://observatoriotransporte.fomento.es/OTLE/LANG_CASTELLANO/)
- Ministry of Public Works: Ports of the State. Statistical Yearbooks  
<http://www.puertos.es/es-es/estadisticas/RestoEstad%C3%ADsticas/anuarioestadisticos/Paginas/2016.aspx>
- Ministry of Public Works: Ports of the State. Annual Reports for Each Port Area  
[http://www.puertos.es/Memorias\\_Anuales/2016/mapa.html](http://www.puertos.es/Memorias_Anuales/2016/mapa.html)

### 10.3. Indicators Used for the Evaluation of Ports

It is important to highlight the challenges faced in obtaining the necessary basic data for this report. Port systems in different countries have different organizations and analysis criteria, making international comparisons extraordinarily complex.

In many cases, port authorities overseeing ports consist of multiple public and private entities and various public administrations. Beyond the governance structure of ports, port operations are carried out by private operators under concession arrangements. This makes port operations highly dependent on competitiveness. The fundamental problem for conducting a comparative study arises from the scarcity of integrated data on port facilities across countries. There are also no databases for port rail connections or databases that capture port automation. In general, it is very difficult to find unified and consistent databases for international port information.

It is also important to note that it was not considered appropriate to assess or consider international trade-related indicators or purely commercial aspects for international comparative analysis. This is because the global report on the analyzed infrastructure sectors focuses solely on infrastructure aspects, in this case, the port sector.



It should also be mentioned that five analysis criteria were not evaluated: Capacity, Operation and Maintenance, Safety, Resilience, and Engineering and Innovation. Reliable and objective databases suitable for these criteria were not found.

However, after a rigorous analysis, it has been concluded that considering the available data, a quantitative assessment can be made in three of the eight criteria considered in the study: Performance, Financing, and Adaptation to the Future and Sustainable Development.

The selected quantitative indicators for evaluation are as follows:

<b>INDICATORS PORTS 2023</b>	
<b>1 CAPACITY</b>	
<b>2 PERFORMANCE</b>	
P.1	Passengers embarked and disembarked in ports / Population
P.2	Passengers embarked and disembarked in ports / GDP (thousands of \$)
P.3	Container traffic (tons) / Population
P.4	Container traffic (tons) / GDP (thousands of \$)
P.5	Container traffic (TEUs) / Population
P.6	Container traffic (TEUs) / GDP (thousands of \$)
P.7	Maritime transport line connectivity index (Index 100 in China in Q1 2006) (UNCTAD)
<b>3 FINANCING</b>	
F.1	Investment in port infrastructure / Population
F.2	% Investment in port infrastructure / GDP (\$)
<b>4 ADAPTATION TO THE FUTURE AND SUSTAINABILITY</b>	
A.4	Cumulative year-on-year growth index of investment in port infrastructure (Index 100 in 2015)
A.5	% Growth of maritime transport lines connectivity (2019/2015) (UNCTAD)
<b>5 OPERATION AND MAINTENANCE</b>	
<b>6 SAFETY</b>	
<b>7 RESILIENCE</b>	
<b>8 ENGINEERING AND INNOVATION</b>	

## 11. Sectorial indicators for Urban Public Transportation

### 11.1. International Indicators for Urban Public Transportation

In the case of the public transportation sector, there is a particularity that sets it apart from other sectors where a single public transportation project is involved, such as roads or railways. This particularity lies in the fact that there are various modes of transportation within public transportation, such as metro, tram, or buses, which employ different public transportation infrastructure. Therefore, to evaluate the entire public transportation sector, these different modes must be considered, which can be complex to aggregate. Additionally, the conception of the modes that make up public transportation is changing with the emergence of some new ones, like ridesharing or public bicycles, which, although currently lacking the transport capacity of other mentioned modes, are gaining popularity.

For the public transportation sector, indicators from the following international organizations have been analyzed: World Bank's Urban Transport Data Analysis Tool, International Association of Public Transport, and the American Public Transportation Association.

Since this sector is specific to each city, most data and indicators are obtained through the local public authorities responsible for coordinating these services in each city. Therefore, when seeking detailed data on urban public transportation in a particular city, the primary source of data is the local authorities responsible for public transportation services in that city. Each city has its own entities responsible for coordinating public transportation within them. In this case, London and Madrid are mentioned as examples, but authorities from all cities included in the study were consulted to update some data and find additional information that may not have been available from other sources. It's worth noting "Transport for London" as a prominent example.

### 11.2. National Indicators for Urban Public Transportation

In Spain, it's essential to highlight the Observatory of Metropolitan Mobility (OOM) as the most valuable national source. OOM is an initiative for analysis and reflection, composed of Public Transport Authorities (ATP) from the main Spanish metropolitan areas, the Ministry for Ecological Transition, the Ministry of Public Works, the Ministry of Industry (through the Institute for Energy Diversification and Savings), and the Ministry of the Interior (through the Directorate-General for Traffic). The purpose of this initiative is to reflect the contribution of public transportation to improving the quality of life and sustainable development in cities. Additionally, the consortia of major Spanish cities have their own databases, such as the Regional Transport Consortium of Madrid.

### 11.3. Indicators Used for the Evaluation of Urban Public Transportation

To compile the Railway report, the following indicators have been used:



Urban Public Transport Indicators. 2023	
<b>1 CAPACITY</b>	
C.1	Use of public transport. Daily trips / Population
C.2	Use of public transport. Daily trips / Area
C.3	Capacity (Buses + Train cars) / Daily trips
C.4	Capacity (Buses + Train cars) / Population
C.5	Capacity (Buses + Train cars) / Area
<b>2 PERFORMANCE</b>	
P.1	Average travel speed (km/h)
P.2	Public transport trips / Motorized trips
P.3	% of population with convenient access to Public Transport (SDG 11.2.1)
P.4	Network length (km) / City Area (KM2)
P.5	Absolute accessibility to public transport within the metropolitan area in 15 minutes
P.6	Absolute bicycle accessibility within the metropolitan area in 15 minutes. OECD
P.7	Absolute walking accessibility within the metropolitan area in 15 minutes. OECD
P.8	Traffic index (Numbeo)
P.9	Time index (Numbeo)
P.10	Dissatisfaction index (Numbeo)
P.11	Inefficiency index (Numbeo)
<b>3 FINANCING</b>	
F.1	Bus network. Revenues / Costs
F.2	Rail network. Revenues / Costs
F.3	Cost (bus network + rail network) / GDP per capita
<b>4 ADAPTATION TO THE FUTURE AND SUSTAINABILITY</b>	
A.1	Mass public transport / Total public transport
A.2	Increase in urban Population
A.3	CO2 emissions index. WB
A.4	Pollution index. WB
A.5	Energy consumption per transported passenger (MJ / (Passenger*km)). WB
A.6	Number of bicycles + scooters / 10,000 inhabitants
A.7	CO2 emissions (t per capita). WB
A.8	Average population exposure to pollutants (micrograms/m3 PM2.5). UN Urban Indicators
A.9	Development of Climate Change Mitigation Technologies related to transport (OECD)
A.10	% of urban population exposed to high noise levels. EUROSTAT
<b>5 OPERATION AND MAINTENANCE</b>	
O.1	Operating expenses / inhabitants
O.2	Operating expenses / GDP
O.3	Operating expenses / Area
<b>6 SAFETY</b>	
S.1	Number of fatalities / 100,000 inhabitants
<b>7 RESILIENCE</b>	
R.1	Network length (km) / City Area (KM2)
R.2	% of population within 1,000 m of a public transport stop (OECD)
R.3	% of population traveling less than 30 minutes on public transport (OECD)
R.4	Hours/year lost in Traffic jams (Tomtom)
R.5	urban core public transport coverage (ITF. Benchmarking accessibility in Cities)
R.6	metropolitan Area public transport coverage (ITF. Benchmarking accessibility in Cities)
R.7	Periurban Area public transport coverage (ITF. Benchmarking accessibility in Cities)
<b>8 ENGINEERING AND INNOVATION</b>	
I.1	Availability of data on Google Maps (Static GTFS + Dynamic GTFS)
I.2	% of GDP allocated to Gross Domestic Expenditure on R&D (OECD R&D)
I.3	Gross Domestic Expenditure on R&D (\$) / Population (OECD R&D)
I.4	Digitalization. Participation in new technologies. Global Competitiveness index score (WEF)
I.5	Digitalization. Index of Information and Communication Technology Infrastructure. (ND Index)
I.6	Digitalization. % of people using the internet
I.7	Engineering. Regulatory transparency. Services Trade Restrictiveness Index (OECD)
I.8	Engineering. Barriers to competition. Services Trade Restrictiveness Index (OECD)
I.9	Engineering. Restrictions on movement. Services Trade Restrictiveness Index (OECD)
I.10	Engineering. Restrictions on the entry of foreign engineers. Services Trade Restrictiveness Index (OECD)
I.11	Innovation index. ND Gain Index

## 12. Organization of work

For the preparation of the second edition, the Board of Directors of Asociación Caminos has appointed a General Coordinator for the work, a Management Coordinator, and six recognized professional Experts (who will act as coordinators for each Sector for the preparation of these sector reports), and a Director of the study.

Under the supervision of the General Coordinator and the Management Coordinator, the Director of the study ensures the fulfillment of the objectives set in the work plan. For this purpose, a schedule of actions is developed, specifying the tasks to be carried out and the dates for their completion. This plan is reviewed every two months. Under the supervision and review of work by the General Coordinator and the Management Coordinator, and with the support of the Sector Coordinators and the two interns, the Director of the Study carries out the following tasks:

- Propose and implement the approved methodology for the development of the work.
- Direct and coordinate the interns hired by Asociación Caminos to support the preparation of the report.
- Provide technical assistance and support for the selection of objective indicators for each sector.
- Locate, calculate, and process publicly accessible databases of objective indicators.
- Support and assist sector coordinators in locating the panel of sectorial experts and draft the survey to be sent to the selected experts.
- Process, synthesize, and evaluate the responses received from the experts.
- Draft the drafts of the global sectoral reports, integrating the results of the objective evaluation with the opinions of the experts.
- Draft the drafts of the executive summary, methodology, and sectoral and global quadrants.

Each Sector Coordinator selects a group of experts who act as members of each Sector. The Sector Coordinator and the selected members propose the survey to be conducted and the panel of experts to whom the evaluation survey will be sent.

For the execution of the work, Asociación Caminos has two interns, who work part-time under the direction of the Director of the Study. The tasks they perform are as follows:

- Locate the required databases to process the selected objective indicators for each Sector. The databases are found in various national and international organizations and institutions.
- Calculate and process the objective indicators of the Sectors. The calculation of the indicators will be carried out through database programs and spreadsheets.
- Prepare and present, through tables and graphs, the results achieved by the indicators.
- Prepare questionnaires and surveys for distribution to the experts in each Sector.
- Process and evaluate the responses and comments received from the experts.
- Support the General Coordinator and the six Sector Experts, as well as the individuals assigned by Asociación Caminos for the preparation of the reports, in carrying out the work.

The final review of the reports has been carried out by the General Coordinator and the Management Coordinator. For the translation of the quadrants, an official translator has been hired, while the sectoral reports, global report, and methodology have been translated by the Management Coordinator.





## 13. Work schedule

The work is carried out in four overlapping phases with a total duration of 15 months:

- Initial Phase: Launch and establishment of the methodology (2 months)
- Quantitative Evaluation: Locating databases, selecting and calculating indicators (7 months)
- Qualitative Evaluation: Preparation, distribution, and processing of surveys (5 months)
- Final Phase: Writing of final sectoral reports, executive summaries, and presentation of the work (4 months)