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Article

Sustainability Indicators to Assess Infrastructure Projects: Sector Disclosure to Interlock with the Global Reporting Initiative

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Abstract. Infrastructure projects have great potential to impact the sustainability of cities due to typically being large-sized projects and having a high level of intervention. Thus, evaluating the sustainability of these projects through sustainability reports is highly relevant, mainly regarding their impacts on the environment, public health, and the local economy. The Global Reporting Initiative (GRI) is the most widespread and internationally accepted Sustainability report tool. However, the GRI does not have an infrastructure sector disclosure. This research addresses this gap by providing a sustainability assessment instrument for infrastructure projects that interlocks with the Global Reporting Initiative (GRI). An extensive and detailed literature review was conducted, identifying 97 potential indicators to measure the sustainability of infrastructure projects. These indicators were evaluated following a top-down approach, conducting a survey of professionals experienced in the relevant field using Lawshe's content validity ratio. The results showed that 42 indicators were validated as essential, with 21 of them, not specifically related to infrastructure projects, already covered by the standard disclosure of the GRI. This assessment enabled the proposal of a sector disclosure formed by 21 new indicators related to the environmental, economic, and social dimensions. This study closes a gap in the evaluation of the sustainability of infrastructure projects and contributes to the discussion about sustainability indicators in infrastructure projects.

Keywords: Urban sustainability, infrastructure projects, indicators, global reporting initiative.

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1. Introduction

The necessity of measuring the sustainability of infrastructure projects has aroused the interest of researchers, as well as governmental and intergovernmental organizations. A significant part of the infrastructures built in several countries demanded large investments [1] and was later classified as unsustainable, because of their harmful effects on the population, fauna, flora, landscape, climate, water, and cultural heritage—this demands evaluation [2].

Many classifications can be adopted for the construction industry; however, in general, it is composed of three subsectors: building, industry, and infrastructure, involving, primarily, construction activities, reconstruction, alteration, repair, and demolition. The products from the "building subsector" are residential and commercial buildings. The products from the "industrial subsector" are factories, refineries, etc. The products from the "infrastructure subsector" are great works of engineering, typically public ones related to transport (roads, bridges, busways, cycleways, footpaths, railways), water (sewage, drainage, water storage, supply), energy (transmission and distribution), communication (transmission and distribution), sanitation, utilities, facilities, and others [3-5].

Despite being a precondition for industrialization and economic development [6,7], impacts caused by infrastructure projects have been cited in several studies, such as new roadways and railway lines—that increase noise pollution [8] and affect the mobility and well-being of communities [9,10] —and dams—that are among the most impactful stressors that affect aquatic ecosystems [11].

Infrastructure projects are typically characterized by large extension, broader and more varied potential impacts [3], and "significant impact on the sustainable construction environment" [12]. These features combined make infrastructure projects have a "great impact on urban and overall project management, mostly because of the large zones of influence" [13].

Sahely et al. [14] stated that massive urban growth had taken place in the previous few decades and that infrastructure projects are crucial to urban sustainability. According to Shen et al. [15], infrastructure projects are vital to the economy of a country but can also cause negative environmental and social impacts.

The construction industry is estimated to account for about 40% of global energy use, as well as 20% of water consumption and 40% of global carbon emissions [16]. In the civil construction sector, infrastructure projects account for a considerable portion of this impact. Statistical data show that there is a correlation between these impacts and the deaths of children under five years of age in developing countries, where 15% die from contaminated water, 36% from infectious respiratory diseases and 22% from chronic lung diseases caused by pollution from dust particles [3].

Thus, infrastructure projects directly impact not only the environment, but also public health, community well-being, the economies of surrounding cities and regions, and urban sustainability [13], reinforcing the demand for indicators of infrastructure project sustainability [12].

Ugwu et al. [13] claim that infrastructure sustainability indicators have a key role in evaluating infrastructure sustainability and stakeholder education. In this context, many infrastructure sustainability indicators and infrastructure indicator frameworks emerged. These frameworks relate indicators, forming a global index [15-20].

However, there is still plenty of scope for improvement in infrastructure project sustainability indicators, mainly concerning relating infrastructure project sustainability to social and economic dimensions, by aligning project sustainability measurement with the Triple Bottom Line model [5, 19,21,22]. One of the biggest problems in evaluating sustainability lies in the identification of sustainability indicators and the selection of the most important indicators [23].

From extensive and detailed bibliographical research, we identified seven infrastructure sustainability indicator lists proposed by researchers [12-15, 17-20]. In general, these lists were generated from case studies, surveys, and governmental guidelines.

Sahely, Kennedy, and Adams [14] state that urban growth has taken place in the last few decades and that infrastructure projects are crucial to urban sustainability. The authors proposed 34 social, economic, environmental, and constructive indicators in a study case conducted in Toronto.

Ugwu, Kumaraswamy, Wong, and Ng [13] claim that infrastructure sustainability indicators have a key role in contributing to the reflection on infrastructure sustainability and the education of stakeholders. The authors used an instrument formulated through a lengthy interview process, study case data, and governmental guidelines. Based on 134 Hong Kong respondents, the result is a model containing 55 indicators.

Ugwu and Haupt [12] highlight the international and urgent demand for measuring infrastructure projects' sustainability. The authors applied Ugwu, Kumaraswamy, Wong, and Ng's [8] indicators in South Africa with little adaptation and including few indicators, resulting in 61 infrastructure sustainability indicators.

Koo, Ariaratnam, and Kavazanjian [24] propose an underground infrastructure sustainability assessment model that emphasizes the social, economic, and environmental dimensions. The authors used the AHP method and an instrument consisting of 47 indicators to enable more sustainable decision making in infrastructure projects.

Shen, Wu, and Zhang [15] reinforce the suggestion that infrastructure projects are vital to the economy of a country but also cause adverse environmental and social impacts. The authors, based on a bibliographical review, propose an instrument consisting of 30 indicators applied in a case study in the Chinese construction industry.

Ariaratnam, Piratla, Cohen, and Olson [18] investigate the social, environmental, and economic impacts of underground infrastructure projects, comparing four underground construction techniques and using 13 sustainability indicators to measure these impacts.

Boz and El-adaway [19] affirm that there is little agreement among stakeholders on what sustainability is and how to measure it. They use a methodology based on expert knowledge and propose a model of sustainability indicators for infrastructure projects containing 22 indicators combining "work" and "nature".

Other researchers have published research about civil construction sustainability indicators in the last few years [15, 22-25]. Some researchers focus on specific infrastructure sustainability indicators, including energy and electricity infrastructure projects [26, 27], transport infrastructure projects [28], rail trains [29], and water supply systems [30].

We also find four infrastructure sustainability indicators proposed by organizations and governments: ASPIRE [31], CEEQUAL [32], ENVISION [33], and GRI Real Estate Sector Disclosure [34].

ASPIRE (A Sustainability, Poverty, and Infrastructure Routine for Evaluation) is a model designed by Engineers Against Poverty in partnership with the multinational Arup Group Limited and is structured around four main themes: environment, society, economy, and institutions. Each theme is subdivided into sub-themes, which in practice are sustainability indicators for each theme, totaling 97 indicators.

CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) is a model that proposes indicators related to twelve areas: project management, land use, landscape issues, ecology and biodiversity, historic environment, water resources and the water environment, energy and carbon, material use, waste management, transport effects on neighbors, and relations with the local community and other stakeholders. The model proposes 241 indicators, where each indicator contributes scores that are linked to summarize the project practices and sustainability consciousness level.

ENVISION was developed by the Institute for Sustainable Infrastructure and engages five categories: quality of life, leadership, resource allocation, natural world and climate, and risk. Each category contains themes, and each indicator addresses issues related to project governance and the resilience of infrastructure projects, aiming to contribute to more resilient and long-term sustainable projects. ENVISION contains 182 indicators.

The GRI sector disclosure for construction and real estate encompasses infrastructure projects, although the disclosure must be used with standard disclosures. The disclosure is aligned with the Triple Bottom Line framework, following the GRI standard. It consists of four areas (economic, environmental, social, and construction and real estate) and 47 indicators.

By analyzing the lists of indicators and models, the predominance of indicators focused on the environmental aspect is evident. This characteristic has been observed in most of the listings produced by researchers, and the list compiled by Ugwu and Haupt [12] contains the highest number of indicators related to social and economic aspects: eight indicators out of 61. Regarding the models, we noted that ASPIRE and the GRI Real State Sector Disclosure align more clearly with the Triple Bottom Line model, while the CEEQUAL and ENVISION again tend to emphasize environmental indicators.

Another observation is the difficulty of focusing on only a few indicators due to the large nature of infrastructure projects. The CEEQUAL model lists 241 indicators, and Ariaratnam et al. [18] and Boz and El-adaway [19] presented the lowest number of indicators, 13 and 22, respectively.

Also, there is an increasing demand for corporate and governmental accountability. Corporations and governments are compelled by society to be transparent about the sustainability of their industrial and managerial activities [35-39]. It is precisely at the point of confluence of the growing need for "accountability" and the holistic concept of sustainability that sustainability reporting models have emerged in the last few decades [40-42].

Sustainability reporting models provide a framework of indicators that facilitates corporate and governmental accountability reports for stakeholders regarding the sustainability of projects [39-41]. Their use has focused mainly on informing the decision-making process of external stakeholders, legitimation, reputational enhancement, and marketing [45].

Studies aiming at the development and improvement of sustainability reports for the private sector have received more attention from researchers [46]. Among these sustainability reporting models, the most widespread and widely accepted internationally is the Global Reporting Initiative (GRI), which is based on the Triple Bottom Line framework and thus encompasses the social, economic, and environmental dimensions of sustainability [47-48]. The GRI provides a standard disclosure format and some sectoral disclosures with indicators for specific sectors [48]. The development of indicators for specific sectors is arousing interest among many researchers [49-52].

The GRI sustainability reporting model consists of two parts: reporting principles and standard disclosures. The reporting principles are accuracy, timeliness, clarity, and reliability. The standard disclosures are divided into general standard disclosures—organizational identity, strategy, stakeholders, and governance—and specific standard disclosures, which include 91 sustainability indicators covering the social, economic, and environmental dimensions [53].

In addition to providing standard disclosures, the GRI contains sustainability reporting models with indicators related to specific sectors, such as the media, airport operation, electric utilities, event organization, financial services, food processing, mining and metals, non-governmental organizations, and oil and gas. The GRI also has a sector disclosure for construction and real estate, the indicators of which are geared towards the construction of buildings. This disclosure sector consists of 47 indicators, of which some are relevant to infrastructure projects, not including specific project indicators of such nature, such as those relating to the water pollution control plan, noise pollution, toxic waste, access to potable water and sanitation services, drainage systems, preservation of historical and archaeological sites, disaster risks, climate change risks, flood risk during site selection, and soil conservation and restoration. Not having a specific sector for infrastructure projects is surprising, considering the potential impacts of these projects on sustainability, particularly on public health [13, 15], worker health [15], environmental health [19], local economies [18], and both public [12-13, 18] and worker safety [24].

Siew et al. [5] conducted a wide-ranging global review of existing models to assess infrastructure project sustainability, concluding that "There is a need to bridge the current gap and look at avenues by which building/infrastructure SRTs can interlock with GRI". Therefore, there is a demand for an instrument to measure the sustainability of infrastructure projects that intentionally involves and relates environmental, social, and economic aspects, following the GRI sectorial content standard.

Furthermore, international bodies, including the United Nations (UN) through the Commission on Sustainable Development, started a research agenda centered on sustainability indicators to facilitate a more measurable discussion of sustainability [43]. This intentional stimulus has led to an accelerated growth of sustainability indicators and models that reconcile indicators, relating them to form a global index, with many of these models being sector-specific [14]. One sector in which the number of indicators and modeling of sustainability indicators is increasing is the infrastructure sector [5].

However, the substantial increase in the number of infrastructure sustainability indicators introduces the risk that it might become too extensive. Also, there are no reports that identify the indicators that must be included in the GRI to improve aspects related to the environmental, social, and economic sustainability dimensions of infrastructure projects.

This study addresses this gap and contributes to the literature handling indicators for the evaluation of infrastructure projects by identifying the indicators considered most important by researchers who publish on the topic, from extensive and detailed bibliographic research. It distinguishes what can be regarded as essential, according to the professionals who work in this field.

Considering the importance of the GRI project sustainability reports in international sustainability assessment, this paper also contributes to the evaluation of infrastructure project sustainability, proposing a GRI infrastructure sector disclosure.

In construction, most studies are geared towards reducing the impacts of building works, so this article also contributes to the sustainable planning and the evaluation of the impacts of a less explored sector—the infrastructure sector.

2. Materials and Methods

2.1. General Approach

Although the GRI is a structure mainly used for organizational reports, some sector contents include specific projects, such as, for example, Construction and Real Estate Sector Disclosure, in this article, we propose specific sector disclosure for infrastructure projects to improve the sustainability assessment of these projects. The strategy adopted was to use only indicators of articles with a specific focus on infrastructure projects. We consider that the fact that these researchers work on the theme establishes a first important filter on the applicability and importance of the indicator and, therefore, from the experience of these authors, we have a set of indicators more relevant, representative and specifically focused on infrastructure projects as a whole.

In this sense, it has three secondary purposes: a) to identify the evaluation indicators of the sustainability of infrastructure projects that are considered most important by researchers who publish on the topic; b) to distinguish which of these indicators can be regarded as essential due to the assessment of professionals working in this field; c) to propose a sustainability assessment instrument for infrastructure projects that interlocks with the Global Reporting Initiative (GRI). The four main steps of the study were bibliographic research, identification of infrastructure sustainability indicators, a survey of expert opinions, and data analysis.

2.2. Bibliographic Research

A bibliographic search was conducted using the keywords "infrastructure," "sustainability," "indicators," and "assessment." We adopted the recommendations of Webster and Watson [54] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

The keyword search returned 924 articles. The articles were screened by a brief study of their titles and abstracts to eliminate non-relevant texts. Publications in journals without peer review systems, those whose full text was not available, and those in languages other than English, Portuguese, or Spanish were also excluded. As a result, 712 titles were excluded.

The remaining 212 articles were screened to exclude models and indicators that were not generally applicable to infrastructure projects. Many studies have been published on civil construction sustainability indicators [4, 22-23]. Some researchers have focused on very specific types of infrastructure projects, leading to very specific sustainability indicators for sectors such as energy and electricity [27], transport [28], railway [29], and water supply [30]. These studies were excluded considering that the resulting sets of indicators were too specific.

Besides, some models of sustainability assessment such as LEED, BREEAM, Green Star, CASBEE, HK-BEAM, NatHERS, BASIX, NABERS, Energy STAR, MFA, PaLATE [5], Envest, UrbanSim, and GreenLITES [19] focus on civil construction as a whole. Conversely, some models focus on specific infrastructure projects, such as Green Roads, which is specific to road infrastructure projects [19]; these models were excluded because they are too focused on specific types of infrastructure projects and are not relevant to infrastructure projects as a whole.

As a result, 201 articles were excluded, and the remaining 11 texts—7 articles and 4 models—were analyzed in detail, becoming the basis for the data collection instrument. Figure 1 summarizes the literature search conducted using the PRISMA flowchart.

2.3. Infrastructure Sustainability Indicators

The indicators found in the papers and models selected through bibliographic research were listed, analyzed, interpreted, and cross-checked. This process resulted in 299 indicators, which were then compared and indexed. The indicators that were not mentioned in more than one source were discarded. This procedure was conducted following the methodological procedures employed in a similar study, in which the same mechanism was used in the face of a comprehensive theoretical framework [15, 54]. As a result, 97 infrastructure sustainability indicators were obtained, which included environmental, economic, and social dimensions (Appendix A).

The strategy of focusing on the indicators with broader bibliographical support concentrates the scope of research to increase the concentration of the respondents and, consequently, the quality of answers [55].

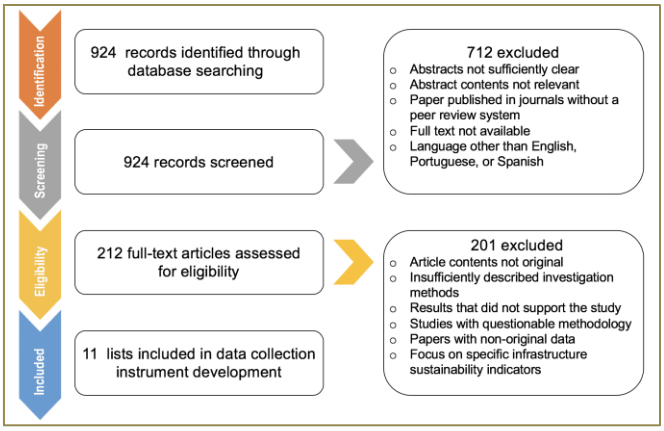

Fig. 1. A literature search using the PRISMA flowchart

2.4. Survey of Expert Opinions

An expert opinion survey involves the determination of the profile of each respondent, data collection, and content validation.

Three main procedures are used to establish sets of indicators for specific sectors: an expert survey (top-down), general stakeholders (bottom-up), and research that mixes the two approaches [22]. Most scientific research and civil engineering sustainability models use the top-down approach, which is based on expert recommendations [12, 19, 26].

Most researches adopt the top-down approach due to the complexity of the concept of sustainability and the holistic paradigm simultaneously involving social, economic, and environmental dimensions, which adds to the complex definition of sustainability indicators [44].

As a consequence of this scenario, researchers have appealed to professionals with expertise in infrastructure projects who also demonstrate knowledge of sustainability concepts and practices [19, 26]. Although this practice significantly reduces the sample of potential respondents, it yields more reliable results.

Thus, this study preferred the methodological option of conducting an online survey with a sample of experts—the top-down approach—with the following profile: active professionals in civil engineering with more than ten years of experience in infrastructure project management and expertise in sustainability.

Respondents received an online version of the research tool presented in Appendix A, containing the 97 indicators resulting from the processes reported in sections 2.2 and 2.3 of this study. The platform used to generate the online surveys was Survey Monkey, whereby the sequence of factors for each respondent was randomized to help prevent bias. The indicators were not organized around the social, economic, and environmental dimensions in the data collection instrument, again to avoid bias.

Some experts were contacted through a personal network of relationships of one of the authors due to his work at the United Nations Office for Project Services (UNOPS). The other experts were contacted through e-mail addresses obtained from 45 publications on infrastructure sustainability and civil engineering sustainability. As for the process of selecting the 45 publications used for the expert panel, from the 212 full-text articles assessed for eligibility (Fig. 1.), we used selected articles with original contents, investigation methods sufficiently described, results that support the study, and focus on infrastructure sustainability indicators, even if they approached only a specific sector of infrastructure.

The first part of the data collected was demographic, and the experts were invited to identify themselves (name, organization name, role, professional qualification, nationality, gender, academic qualification, organization type, length of experience, and technical-scientific knowledge on sustainability).

All respondents stated that they possessed ten or more years of experience in infrastructure project management. The experts were also invited to share their knowledge regarding infrastructure project sustainability, including indicating their understanding of the models used in the present study or other sustainability models. The results are shown in Fig. 3. The experts were further invited to evaluate the relevance of each indicator to the sustainability of infrastructure projects.

The data collection ran for 12 weeks, and 25 respondents completed the survey. Thus, the sample was non-probabilistic and intentional, with a focus on experts who met the profile established in section 2.4 on the determination of the profiles of the respondents.

To establish the essential infrastructure sustainability indicators based on the data collected, the content validation process proposed by Lawshe [56] was used, which considers the expert evaluation of indicators as "essential," "useful, but not essential," or "not useful" to determine which indicators should compose the research instrument used to measure a given universe, according to the calculated content validity ratio (CVR).

Linked to the CVR, Lawshe proposed a minimum number of "essential" answers from experts based on the number of respondents for each item to be validated or otherwise in the final instrument, called the Critical N. The Critical N reformulated by Ayre and Scally [57] was used in the present study. The indicators were validated in view of the number of "essential" answers of the specialists.

The reliability of the data collection instrument and the respondents was estimated using Cronbach's alpha [58], which relates item and respondent variance.

3. Results

3.1. Selected Indicators

Ninety-seven infrastructure sustainability indicators were selected according to the bibliographical research, as shown in Appendix A. Of the 97 selected indicators, 63 are focused on environmental dimensions, ten on economic dimensions, and 24 on social dimensions.

3.2. Survey Results

Initially, we calculated Cronbach's alpha of the dataset to be 0.969, which indicates that the data are highly reliable and confirms the reliability of the research data. The next step was to use the demographic data from the first section of the questionnaire to obtain the profile of the respondents. Most respondents work in engineering (60% of respondents), followed by those who work in management (40%).

Figure 2 presents the data related to the respondents' knowledge about infrastructure sustainability models and sustainability tools. The experts evaluated each indicator according to its relevance in measuring the sustainability of infrastructure projects (Appendix A). As determined using the Critical CVR proposed by Ayre and Scally [57], the minimum number of "essential" evaluations for each indicator is 18, considering that 25 specialists contributed to the research.

Fig. 2. Self-reported knowledge of the expert respondents of infrastructure sustainability models and tools

Table 1 shows the indicators which were considered essential by, at least, 18 specialists. To improve the measurement of the economic aspect, the economic indicators that came closest to the limit of the critical CVR were included: "economic benefits," "durability of structures," "cost of any relocation of people," and "ecosystem rehabilitation cost." The experts evaluated each indicator according to its relevance in measuring the sustainability of infrastructure projects (Appendix A). As determined using the Critical CVR proposed by Ayre and Scally [57], the minimum number of "essential" evaluations for each indicator is 18, considering that 25 specialists contributed to the research.

Figure 3 summarizes the evaluation of the essentiality of the indicators greater than 80%, considering the respondents' professional area.

4. GRI Sector Disclosure Proposed for Infrastructure Projects

The objective of this research was to develop a sustainability assessment instrument for infrastructure projects that interlocks with the Global Initiative Reporting (GRI). As well as specific contents for other sectors that already exist—airport operators, electric utilities, oil and gas, event organizer and others—this study proposes infrastructure project-specific content. Considering that all specific contents must be utilized jointly with the GRI standard content, we compared the indicators resulting from this study with those used by the GRI at standard disclosures. By doing so, it was possible to note that some are already considered in the standard disclosures (Table 2).

Table 3 presents the specific infrastructure indicators that are not covered by the GRI standard disclosures, which together form the infrastructure sector disclosure proposed in the present report to interlock with the GRI. The indicators were listed following the standard used by GRI for its contents for specific sectors: the prefix "EC" is for economic indicators, the prefix

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"EN" is for environmental indicators, and the prefix "SO" is for social indicators. The economic indicators were placed first, followed by the environmental and social indicators, again according to the GRI standard.

.Table 1. Infrastructure sustainability indicators which were considered essential by, at least, 18 specialists.

Dimension	Indicator	Focus
Environmental	1. Aquatic ecosystem preservation	Environmental preservation
	2. Biodiversity preservation	
	3. Preservation of historical and archaeological sites	
	4. Protected area preservation	
	5. Soil conservation	
	6. Water preservation	
	7. Air pollution	Pollution management and control
	8. CO_2 emissions	
	9. Environment pollution control plan	
	10. Greenhouse gas emissions	
	11. Long-term ground/soil contamination	
	12. Long-term water pollution	
	13. Noise pollution	
	14. Toxic waste management	
	15. Waste disposal method	
	16. Water pollution control plan	
	17. Potable water consumption	
	18. Water reuse and recycling	
	19. Environmental management	Environmental management
	20. Establishment of a sustainability management system	
	21. Impact on the natural environment	
	22. Climate change risks and resilience	Environmental risk management
	23. Disaster risks	
	24. Flood risk during site selection	
	25. Risk of landslides, erosion, and sedimentation	
	26. Risk management	
	27. Drainage systems	Sustainable Practices
	28. Soil restoration	
	29. Sustainable material source	
Economic	30. Ecosystem rehabilitation cost	Environmental costs
	31. Costs of any relocation of people	
	32. Durability of structures	Economic benefits
	33. Economic benefits	
Social	34. Access to potable water and sanitation services	Public and worker health and safety
	35. Accidents, injuries, fatalities, etc.	
	36. Public health	
	37. Public safety	
	38. Worker health	
	39. Worker safety	
	40. Conflict sensitivity from locals	Social Responsibility
	41. Social and cultural impact due to the project	
	42. Project governance and strategic management	Governance

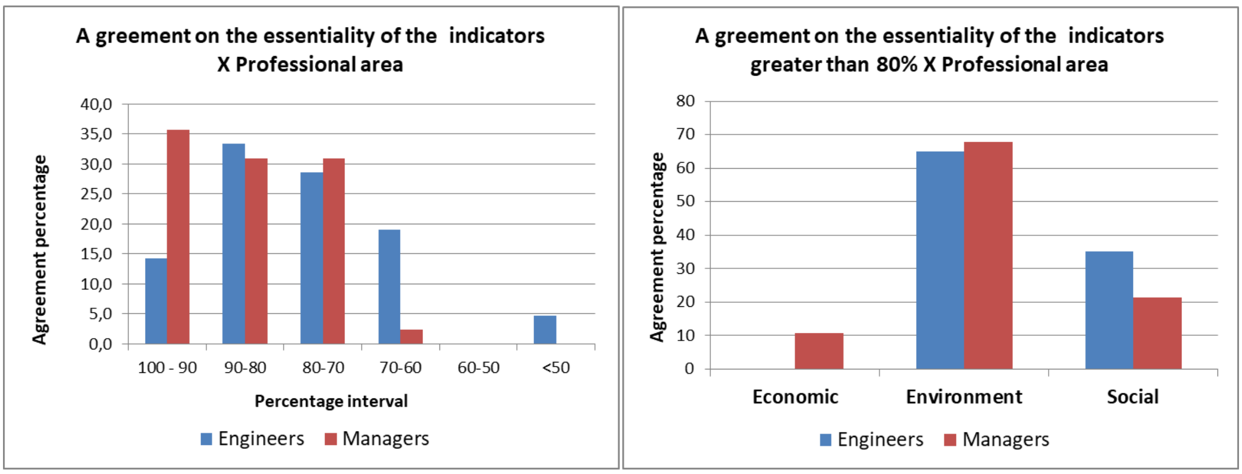

Fig. 3. Evaluation on the essentiality of the indicators.

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Table 2. Indicators already considered in GRI-specific standard disclosures.

Infrastructure indicators	**Indicators of specific standard disclosures**	**Indicator Identification according to GRI**
Impact on the natural environment	Extent of mitigation of environmental impacts of products and services.	G4-EN27
	Significant environmental impacts of transporting products and other goods and materials for the operation of the organization and transporting workforce members.	G4-EN30
Environmental management	The extent of impact mitigation of environmental impacts of products and services	G4-EN27
	Total environmental protection expenditures and investment by type	G4-EN31
Toxic waste management	Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention 2 Annex I, II, III, and VIII and the percentage of transported waste shipped internationally	G4-EN25
Water reuse and recycling	Percentage and total volume of water recycled and reused	G4-EN10
Potable water consumption	Total water withdrawal by source	G4-EN8
Air pollution	NOx, SOx, and other significant air emissions	G4-EN21
CO2 emissions	NOx, SOx, and other significant air emissions	G4-EN21
Climate change risks and resilience	Financial implications and other risks and opportunities for the activities of an organization due to climate change	G4-EC2
Biodiversity preservation	Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas	G4-EN12
	Total number of IUCN red list species and national conservation list species with habitats in areas affected by operations, by the level of extinction risk	G4-EN14
Long-term water pollution	Identity, size, protected status, and value of water bodies and related habitats significantly affected by the discharge of water and runoff	G4-EN26
Waste disposal method	Total weight of waste by type and disposal method	G4-EN23
Greenhouse gas emissions	Direct Greenhouse Gas (GHG) emissions (scope 1)	G4-EN15
	Energy indirect GHG emissions (scope 2)	G4-EN16
	Other indirect GHG emissions (scope 3)	G4-EN17
	GHG emission intensity	G4-EN18
Protected area preservation	Operational sites owned, leased, managed in, or adjacent to protected areas and areas of high biodiversity value outside protected areas	G4-EN11
Water preservation	Water sources significantly affected by the withdrawal of water	G4-EN9
Economic benefits	Direct economic value generated and distributed	G4-EN9
Public safety	(Customer Health and Safety) Percentage of significant product and service categories for which health and safety impacts are assessed for improvement	G4-PR1
	Total number of incidents of non-compliance with regulations and voluntary codes concerning the health and safety impacts of products and services during their life cycles, by type of outcome	G4-PR2
Public health	(Customer Health and Safety) Percentage of significant product and service categories for which health and safety impacts are assessed for improvement	G4-PR1
	Total number of incidents of non-compliance with regulations and voluntary codes concerning the health and safety impacts of products and services during their life cycles, by type of outcomes	G4-PR2
Worker safety	Percentage of the total workforce represented in formal joint management–worker health and safety committees that help monitor and provide advice regarding occupational health and safety programs	G4-LA5
	Health and safety topics covered in formal agreements with trade unions	G4-LA8
Worker health	Percentage of the total workforce represented in formal joint management–worker health and safety committees that help monitor and provide advice regarding occupational health and safety programs	G4-LA5
	Health and safety topics covered in formal agreements with trade unions	G4-LA8
Social and cultural impacts of the project	Operations with significant actual and potential negative impacts on local communities	G4-SO2
Accidents, injuries, fatalities, etc.	Types and rates of injury, occupational diseases, lost days, absenteeism, and the total number of work-related fatalities, by region and by gender	G4-LA6

Table 3. Proposed infrastructure sector disclosure to interlock with the Global Reporting Initiative

Aspects	Indicators	Report Guidelines
Economic	EC-01 Cost of any relocation of people	Report each action of relocation. Inform the cost of each action and the total cost. Present the percentage of the cost of each action in relation to the total cost of relocation and the total cost of relocation in relation to the total cost of the project.
	EC-02 Durability of structures	Report, during the design and specification phases, if the team considered the durability and maintenance requirements of structures and components. Report which aspects for durability were implemented in construction.
	EC-03 Ecosystem rehabilitation cost	Report each action of rehabilitation. Present the cost of each action and the total cost. Present the percentage of the cost of each action in relation to the total cost of rehabilitation and the total cost of rehabilitation in relation to the total cost of the project.
Environmental	EN-01 Aquatic ecosystem preservation	Report the total actions of preservation and protection of rivers, lakes, vernal pools, wetlands, shorelines, or waterbodies performed, as well as to characterize them, their scope, their frequency, and their importance for the reduction of impacts.
	EN-02 Disaster risks	Report if, during the planning and design phases, the team considered the possibilities of flood risk, quakes, and potential natural risks. Report which specific actions have been taken to prevent and mitigate risks.
	EN-03 Drainage systems	Report if sustainable drainage systems have been incorporated in the scheme where appropriate. Present which drainage system is used, the impacts caused, and the actions of prevention/mitigation.
	EN-04 Environnent pollution control plan	Report the standards, methodologies, and assumptions used, including if the information is calculated, estimated, modeled, or originated from the direct measurements, and also the approach to do so. Specify actions to prevent and mitigate air, land, and water pollutions during construction.
	EN-05 Establish a sustainability management system	Report how the sustainability management system considers the scope, scale, and complexity of the project. Introduce standards, methodologies, and assumptions used, including if the information is calculated, estimated, modeled, or originated from the direct measurements, and also the approach to do so.
	EN-06 Flood risk during site selection	Report if the team considered the characteristics, the environmental issues, and flood risk during the selection of the site location. Report which specific actions have been taken to prevent and mitigate risks.
	EN-07 Risk of landslides, erosion, and sedimentation	Report if the team considered the risks of landslides, erosion, and sedimentation on the planning and design stages. Present which specific actions have been taken to manage erosion and prevent landslides.
	EN-08 Long-term ground/soil contamination	Report how the measures and equipment were incorporated into the project, which will allow the long-term monitoring of the project's impact on the soil. Notify the sources of contamination factors, quantifying the types of contamination that occurred, the extent of the impacts and the measurements to be taken to reduce these impacts.
	EN-09 Noise pollution	Report if, during the planning and design phases, the team considered monitoring and mitigation of ambient noise to reduce noise to accepted standard target levels during and after construction. Notify the sources of the factors of emissions, quantifying the extent of the impacts and the measurements to be taken to reduce these impacts.
	EN-10 Preservation of historical and archaeological sites	Report how the historical and archaeological sites are identified and develop a sensitive design and approach to conservation and protection. Present the total number of preservation actions and characterize them, their scope, their frequency, and their importance to the reduction of possible impacts.
	EN-11 Risk management	Report if, during the planning and the design phases, the team developed a documented plan to identify and mitigate risks concerning the many areas of the project. Report which specific actions have been taken to prevent and mitigate risks.
	EN-12 Soil conservation	Report if, during the planning and the design phases, the team considered actions for the conservation of topsoil and subsoil and conservation of on-site mineral resources. Report which specific actions have been implemented in the construction stage.
	EN-13 Soil restoration	Report in square kilometers the extension of the land remediated for the existing or intended land use, according to applicable legal designations. Report which specific actions have been implemented for the soil restoration.
	EN-14 Sustainable material source	Report if, during the planning and the design phases, the team considered responsible sourcing of sustainable materials. Report which specific actions have been taken for the use of sustainable materials.
	EN-15 Water pollution control plan	Report if, during the planning and the design phases, the team created a plan to control the impacts of the project on the water environment during construction. Notify about standards, methodologies, and assumptions used, including if the information is calculated, estimated, modeled, or originated from the direct measurements and the approach used to do so. Report which specific actions have been taken to control the impacts of the project on the water in the construction stage.
Social	SO-01 Access to potable water and sanitation services	Report if, during the planning and the design phases, the team considered the availability of potable water and sanitation to workers. Report the availability of potable water and sanitation to workers in the construction stage.
	SO-02 Conflict sensitivity from locals	Report if, during the planning and design phases, the team inquired about local customs. Report if the team monitored and managed possible conflicts in the construction stage.
	SO-03 Project governance and strategic management	Report if appropriately skilled personnel were commissioned to undertake the implementation of the management plan, monitoring of the establishment, and review of the objectives and management prescriptions.

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Figure 4 shows the number of indicators grouped by focus and Fig. 5 shows the number of indicators of the sustainability assessment tools grouped by the sustainability dimension.

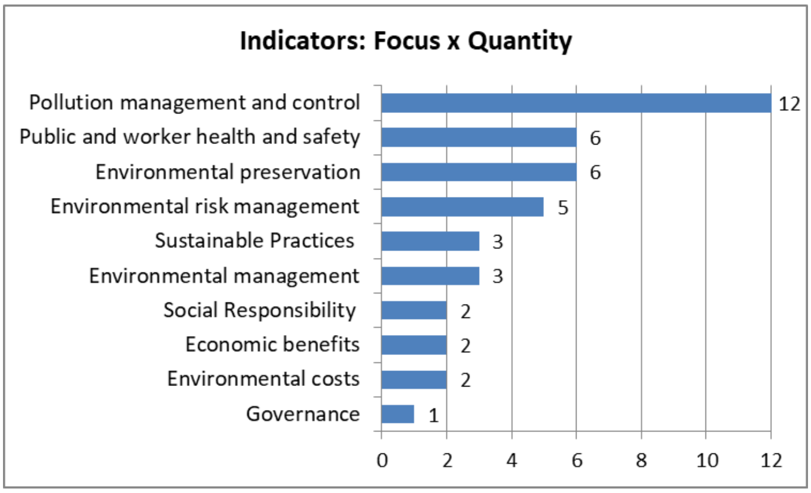

Fig. 4. Number of indicators grouped by focus.

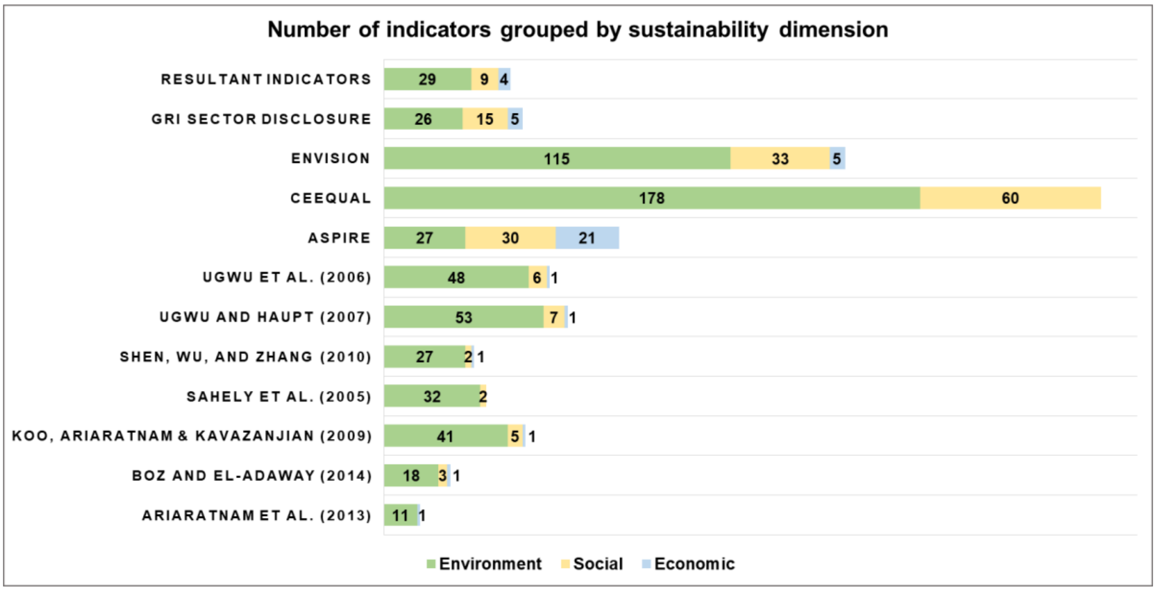

Fig. 5. Number of indicators of the sustainability assessment tools grouped by sustainability dimension.

5. Discussion

In general, environmental indicators are, to a greater or lesser extent, related to environmental health. More specifically, environmental indicators mainly reflect the concern with reducing pollution on the one hand and maximizing preservation on the other, essential and complementary actions in terms of the environmental health of a city or region.

Of the nine social indicators, six are directly related to public or worker health, demonstrating that an important aspect of social sustainability is related to how infrastructure projects impact the health of the people most directly affected by this type of project—people living in the neighborhood and the workers. Of the other social indicators, two are related to the project's social responsibility to the affected community, and one represents the project's governance issues, emphasizing the importance of project leadership for sustainability.

Two economic indicators involve environmental costs, and two involve economic benefits, of which one targets the economic benefits to the surrounding community arising from the project, and one measures the costs given the life cycle, durability, and maintenance of the project. The results show that the environmental aspect significantly influenced the judgment of the experts regarding the sustainability of infrastructure projects. The resulting indicators also reflected the tendency to utilize a higher proportion of environmental sustainability indicators, which is in agreement with previous studies [5, 14, 19, 22, 59, 60].

When we consider the indicators evaluated as essential (Table 1), analysis of Fig. 3 shows that regarding the professional area, the assessment of managers concerning the essentiality was mainly between 70 and 90% of the indicators, and those of the engineers were between 70 and 100%. Only less than 5% of engineers assessed that less than 50% of the indicators are essential. When we consider the essentiality of the indicators above 80%, the analysis of Fig. 3 shows that for the environmental dimension, the evaluation of engineers and managers was very similar, between 60 and 70%. Regarding the economic and social dimensions, the engineers did not attribute this essentiality to the economic indicators, giving greater emphasis to the social aspects.

One possible explanation for this result concerns the difference between professional activities. The engineer is responsible for the operationalization of the construction activities, which makes the environmental and social impacts more visible than the economic ones. Besides, it is common to find as a characteristic of the engineer's profile, that of being able to understand the impact of engineering solutions in the socio-environmental context. In the project management environment, the factors of scope, time, and cost are conflicting and interdependent. They must be balanced by the project manager for the project success, which is why they are called Triple Constraint. Thus, the cost factor is more present in the activities of managers than in that of engineers.

These analyses show that the economic indicators are still a controversial aspect and are little explored in the field of sustainability indicators in infrastructure projects, which is confirmed by Boz & El-adaway [19]. Also, environmental indicators tend to be considered more critical than others.

Analysis of the indicators considered essential for engineers and managers reveals a significant presence of indicators linked to risk management: flood risk during site selection; risk management; climate change risks and resilience, risk of landslides, erosion, and sedimentation; and disaster risks, which is in agreement with the literature that states the high level of risk involving infrastructure projects due to their extension and impact [3, 12,13, 61].

Figure 4 shows that the 42 indicators can be grouped according to their focus on ten themes, of which Pollution management and control (29%), Environmental preservation (14%), and Public and worker health and safety (14 %) contains more than 50% of the indicators. In the discussions on sustainability, in general, these three themes have been widely discussed.

Comparing the essential indicators with other related instruments, it is possible to notice a considerable reduction in the number of indicators regarding ENVISION, CEEQUAL, ASPIRE, Ugwu et al. [13], and Ugwu and Haupt [9]. At the same time, the resulting indicators involve the environmental, economic and social aspects by following the holistic model of the Triple Bottom Line, with a better balance than ENSIVION, CEEQUAL, Ugwu, et al. [13], Ugwu and Haupt [10], Shen et al. [15], Sahely et al. [14], Koo et al. [24], Boz & El-Adaway [19] and Ariaratnam et al. [18]. Considering the number of indicators for the environmental, economic, and social aspects, the most balanced instrument in this scenario is ASPIRE, as shown in Fig. 5.

When comparing the essential indicators with the sectoral contents of GRI "Construction and Real Estate", it is possible to notice that specific indicators of infrastructure projects are missing in this sectorial content, such as noise pollution, toxic waste, preservation of historical and archaeological sites, disaster risks, climate change risks, flood risk during site selection, likelihood of landslides, erosion and sedimentation, access to potable water and sanitation services, drainage systems, life-cycle cost, and durability of structures.

This result is in agreement with the research of Liu et al. [62] that compared instruments intended to measure sustainability in construction projects in general and specific instruments for infrastructure projects. The authors conclude that particular aspects are covered only by tools of measurement in infrastructure projects, such as durability, benefits, landscape, humanities, culture, and creativity.

Considering that out of the 42 indicators that are considered essential 21 are already considered by the GRI, the data in Fig. 6 show that most of the additional indicators added in GRI by the infrastructure sector disclosure are related to pollution management and control (8) and public and worker health and safety (5), representing 62% of the total additional indicators.

6. Conclusion

Due to their scale and nature, infrastructure projects can have significant environmental, social, and economic impacts. Aimed at evaluating the sustainability of these projects, several researchers have related indicators considered appropriate to this kind of analysis. However, the substantial increase in the number of infrastructure sustainability indicators introduces the risk that it might become too extensive. A significant problem related to the evaluation process through indicators is to identify sustainability indicators and to select an indicator set.

At the same time, there are specific aspects of infrastructure projects that are not covered by the indicators of sustainability-reporting instruments for construction in general. Also, there are no reports that identify the indicators that must be included in the GRI to improve aspects related to the environmental, social, and economic health of infrastructure projects. This study addresses these gaps.

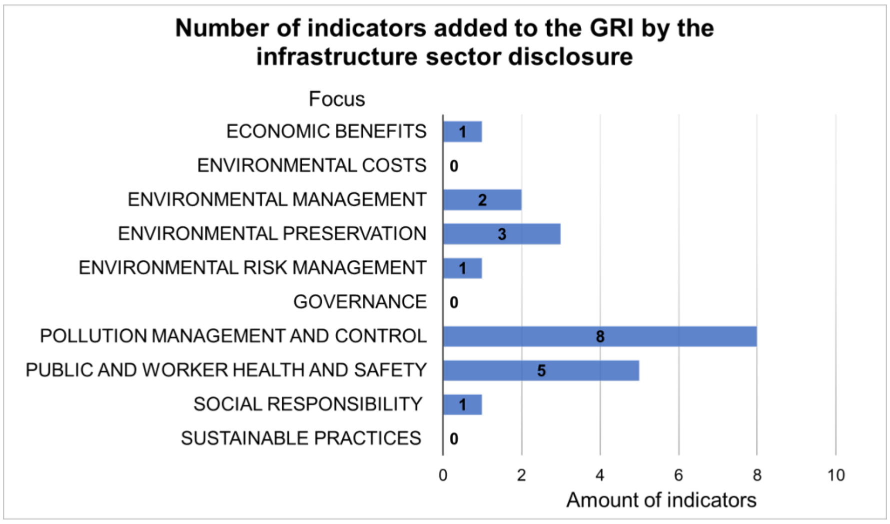

Fig. 6. Amount added to the GRI indicators by the infrastructure sector disclosure for each focus of approach.

At the same time, there are specific aspects of infrastructure projects that are not covered by the indicators of sustainability-reporting instruments for construction in general. Also, there are no reports that identify the indicators that must be included in the GRI to improve aspects related to the environmental, social, and economic health of infrastructure projects. This study addresses these gaps.

As for the goal of identifying the indicators of evaluating the sustainability of infrastructure projects considered the most important by researchers who publish on the topic, the strategy of focusing on the indicators with broader bibliographical support that concentrates the scope of research to increase the concentration of the respondents and consequently the quality of answers was adopted. After extensive analysis to eliminate redundancies, the result was a relation containing 97 indicators considered by researchers as suitable for the evaluation of infrastructure sustainability. This summary of indicators is an important contribution to the literature on the subject.

The results show that the environmental aspect significantly influenced the judgment of the experts regarding the sustainability of infrastructure projects, and, in general, environmental indicators are, to a greater or lesser extent, related to environmental health. Regarding the goal of identifying indicators that can be considered essential, following an experts' opinion survey, we found that 42 indicators may be considered essential to assess the sustainability of the infrastructure projects. The possibility of reducing the number of indicators to be evaluated, considering only the essential ones, is an important contribution for professionals in the area.

As for the objective to propose a specific set of indicators that enable the inclusion in the GRI project sustainability reports of a specific sector to assess the sustainability of the infrastructure projects, using the relation of the indicators considered essential as its basis, we found the need to add 21 indicators.

Considering the importance of the GRI project sustainability reports in international sustainability assessment, this paper contributes to the evaluation of infrastructure project sustainability, proposing a GRI infrastructure sector disclosure.

The results show that of the 21 indicators proposed for the infrastructure sector disclosure, eight are related to pollution management and control, and five are related to public and worker health and safety. The results also show that economic indicators are still a controversial aspect and are little explored in the field of sustainability indicators in infrastructure projects, agreeing with other researchers' work on the theme.

The comparison of the indicators considered essential to the other related instruments in this study shows a significant reduction in the number of indicators, involving environmental, economic, and social aspects by following the holistic model of the Triple Bottom Line.

This study has a typical research limitation based on the literature review. Although extensive and detailed bibliographic research was conducted, the possibility remains that something important may not have been studied. Also, It is important to stress that by focusing on fewer indicators, it is possible that indicators that are relevant to specific realities, depending on the location and characteristics of the infrastructure project, may not be considered.

To improve the results of this research, we have two suggestions. The first is to conduct a survey with specialists in infrastructure projects to identify other economic and social indicators based on the experience of these professionals, since in the literature on the subject, there are few references to this type of indicator. The second is to use the set of identified indicators in real cases of infrastructure projects to assess the needs for improvement concerning their effectiveness for the dissemination of sustainability aspects. However, we recognize that this will be a time-consuming process, considering the deadlines usually demanded by this type of project. We hope that future developments of this research will encourage other researchers to identify and quantify the impacts of infrastructure projects.

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Conflicts of Interest

The authors declare no conflict of interest.

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Appendix A. Data collection instrument containing Infrastructure sustainability indicators resulting from bibliographic research

Dimension	Indicator	Definition
Environment	1. Air pollution	Minimization of adverse impacts on the local air quality by taking appropriate measures at the construction stage
	2. CO_2 emissions	CO_2 emissions of the project during construction and CO_2 emission assessment
	3. Greenhouse gas emissions	Greenhouse gas emission intensity of the entire project
	4. Indirect emissions	Emissions from the manufacturing and transportation of building materials and construction equipment and offsite construction-related staff activities
	5. Indoor air quality	Minimization of adverse impacts on indoor air quality during the construction stage by taking appropriate measures in design and construction
	6. Aquatic ecosystem preservation	Preservation and protection of rivers, lakes, vernal pools, wetlands, shorelines, or waterbodies
	7. Impact of the assessment on water under competent legislation	Consultation with regulatory authorities about water issues related to the project, including the need for any consents
	8. Long-term water pollution	Incorporation of measures or equipment into the project that will allow long-term monitoring of the impact of the project on the water environment
	9. Potable water consumption	Incorporation of means to monitor water performance during operations
	10. Water pollution control plan	Creation and implementation of a plan to control the impacts of the project on the water environment during construction
	11. Water preservation	At the construction stage, protection of existing water features from degradation or physical damage by the construction plant and processes
	12. Water reuse and recycling	Potable water consumption reduction through water reuse and recycling
	13. Land acquisition	Minimization of the need for land acquisition (outright purchases and/or expropriation of property and purchases of access rights such as rights of way)
	14. Habitat and feeding ground preservation	Extent of loss of habitat or feeding grounds
	15. Risk of landslides, erosion, and sedimentation	Following of best-management practices to manage erosion and prevent landslides
	16. Long-term ground/soil contamination	Incorporation of measures or equipment into the project that will allow long-term monitoring of the project's impact on the soil
	17. Soil conservation	Conservation of topsoil and subsoil and conservation of on-site mineral resources
	18. Soil restoration	Land remediated and in need of remediation for the existing or intended land use, according to applicable legal designations
	19. Dredged/excavated material	Design of the project to balance cut and fill to reduce the dredged/excavated material taken off site
	20. Environmental management	Creation and use of a unified document to consider and assess the environmental aspects for each stage of the project
	21. Environment pollution control plan	Creation and implementation of an environment pollution control plan to specify actions to prevent and mitigate pollution to air, land, and water during construction
	22. Impact on the natural environment	Impact on the natural environment, such as soil, air, water, and ecosystems
	23. Effects on trees within the project limits	Percentage of substantial trees present on the site that have been retained
	24. Insertion of invasive species	Insertion of invasive plants and animals into the environment
	25. Preservation of historic and archaeological sites	Identification historic and archaeological sites and develop a sensitive design and approach to conservation and protection
	26. Protected area preservation	Preservation of a protected area, landscape, or townscape
	27. Biodiversity preservation	Preservation of the local biodiversity
	28. Research and innovation	Development and implementation of innovative technologies or methods
	29. Life cycle energy	Life cycle energy assessment for the key materials and components to be used

	assessment	in the project
30.	Energy consumption	Consideration of the energy consumption of the project during construction and energy consumption assessment
31.	Energy consumption reduction	Energy consumption reductions achieved during project lifetime
32.	Renewable energy use	Extent of renewable energy use to meet the energy needs of the project during construction
33.	Innovative material	Implementation of innovative materials in the project
34.	Use of regional materials	Research of all the locally available material sources, including recycled materials, by the designer and contractor
35.	Use of recycled materials	Identification of the appropriate reuse of existing structures and materials on the site and incorporation into the project
36.	Material consumption	Material consumption by volume of material incorporated into the project
37.	Material recycling after decommissioning	Recycling or reuse of materials after the useful life of the project has ended and after disassembly by the owner and project team
38.	Prefabricated material	Consideration of the selection and use of prefabricated units, such as pre-cast concrete units and panels
39.	Sustainable material source	Consideration and implementation of responsible sourcing of sustainable materials
40.	Risk management	Development of a documented plan to identify and mitigate risks concerning the project
41.	Climate change risks and resilience	Creation of a climate impact assessment and adaptation plan that identifies climate change risks and possible responses
42.	Disaster risks	Consideration of flood risk, quakes, and potential natural risks in the planning and design phase
43.	Flood risk during site selection	Consideration of the site characteristics, environmental issues, and flood risk during the selection of the site location
44.	Establish a sustainability management system	Creation of a sustainability management policy commensurate with the scope, scale, and complexity of the project; assessment and prioritization of the environmental, economic, and social aspects of the project; and definition of project sustainability goals, objectives, and targets appropriate for the affected communities
45.	Long-term planned maintenance	Consideration of long-term planned maintenance in the design process
46.	Mitigating vibration	Performance of appropriate studies to predict the levels of vibration during construction and proposals for ambient vibration mitigation and monitoring
47.	Noise pollution	Monitoring and mitigation of ambient noise to reduce noise to accepted standard target levels during and after construction
48.	Light pollution	Consideration of appropriate measures to prevent light spillage to neighboring areas during operation
49.	Construction traffic management plan	Creation and implementation of a construction traffic management plan for minimizing the disruption caused by construction traffic
50.	Sustainable procurement practices	Definition of a sound and viable sustainable procurement program
51.	Approach/criteria towards contractors	Contract requirements for the designers and contractors expressly include the achievement of specified environmental and social performance
52.	Selection of an effective contract type	The construction contract includes clauses on the preservation of the environment and sustainability
53.	Design for disassembly	Active inclusion of a design for disassembly and/or deconstruction at the planning and design phase
54.	Quality of infrastructure	Consideration of a high quality of design, fully achieved in the construction stage
55.	Drainage systems	Consideration of the incorporation of sustainable drainage systems
56.	Toxic waste management	Development, execution, and monitoring of a comprehensive toxic waste management plan
57.	Waste disposal method	Specific documented mechanisms for managing waste and identifying and dealing with all waste arising from the civil engineering work
58.	Non-toxic waste management	Development, execution, and monitoring of a comprehensive non-toxic waste management plan
59.	Traffic congestion	Consideration of measures to minimize the traffic impacts of the completed project on the local community
60.	Transport impact	Consideration of transport impacts during the construction and design stages as well as appropriate measures to minimize them

	61. View from competent authorities	The project is in accordance with the aims of applicable policies published by the relevant local, regional, or national authority
	62. Visual harmony with the surroundings	Consideration of visual harmony with the landscape and other construction at each stage of the project
	63. Visual impact	Minimization of the adverse visual impact of the site during the construction stage
Economic	64. Adverse impact on tourism values	Negative economic impact on local tourism
	65. Economic impact on surrounding businesses	Economic impact assessment in the local community
	66. Economic benefits	Economic growth and development of the local community generated by the project
	67. Affordability for users	Affordable costs, compatible with the capacity of users to pay for the services
	68. Durability of structures	Consideration of active durability and maintenance requirements of structures and components in the design and specification stage
	69. Life cycle cost	Costs involving construction completion along with the effect of cost decisions on using, maintaining, and supporting the infrastructure
	70. Maintenance, operation, and rehabilitation costs of the completed project	Costs of resources allocated to the monitoring, maintenance, and rehabilitation of the completed project
	71. Rehabilitation cost of the ecosystem	Costs involving the rehabilitation of the ecosystem as a significant indirect economic impact due to project development
	72. Social costs due to the project development	Social costs involving land tenure and other issues relative to locals
	73. Costs for any relocation of people	Cost of resettling people
Social	74. Project governance and strategic management	Appropriately skilled personnel commissioned to undertake the implementation of the management plan, monitoring of the establishment, and review of the objectives and management prescriptions
	75. Stakeholder management	Documented plan to identify and manage the stakeholders
	76. Participation of stakeholders	Carry out a community consultation at each stage of the project
	77. Accountability and grievance mechanisms for stakeholders	Mechanisms to ensure that comments from the local community will be recorded
	78. Conflict management from locals	The project team is aware of local customs and monitors and manage possible conflicts
	79. Respect for local customs	Reasonable determination of the local customs and informing the workers of them
	80. Social and cultural impact due to the project	Consideration of the wider social impacts of the project during construction and operation and the effects of the completed project on the human environment
	81. Displacement and resident relocation	Number of persons voluntarily and involuntarily displaced and/or resettled
	82. Addition of benefits to users	The completed project creates new capacity or increases the quality of the existing, operating, recreational, or cultural capacity for business, industry, or the public
	83. Mobility and transport	Incorporation of design strategies to address access and mobility concerns during and after construction
	84. Extent of blockage	Traffic impacts of the completed project on the local community
	85. Enhance the public space	The project adds to the public space in a way that significantly enhances community livability
	86. Employment of labor	The project creates a significant number of new jobs during its design, construction, and operation
	87. Intergenerational and gender practices	Composition of governance bodies and breakdown of employees per employee category according to gender, age group, minority group membership, and other indicators of diversity
	88. Employee training	Average hours of training per employee by gender and employee category
	89. Public health	Reduction of the risks to public health to acceptable levels and receipt of approval from the appropriate public health officials

90.	Public participation	Acquisition of input from and alignment between the views of the project team and those of local officials, communities, and decision makers
91.	Public safety	Reduce the risk to public safety to acceptable levels and receive approval from the appropriate public safety officials
92.	Public services	Incorporation of design strategies to provide and improve public services, such as transportation infrastructure efficiency, walkability, and livability
93.	Worker health	Reduction of the risks to worker health to acceptable levels and receipt of approval from the appropriate public health officials
94.	Access to potable water and sanitation services	Potable water and sanitation available to workers
95.	Worker safety	Reduction of the risks to worker safety to acceptable levels and receipt of approval from the appropriate public safety officials
96.	Accidents, injuries, fatalities, etc.	Types of injury and rates of injury, occupational diseases, lost days, absenteeism, and the total number of work-related fatalities
97.	Project duration	Period of time from the beginning of execution of an element to its completion

Ricardo Prata Fernandes Ferrarez, photograph and biography not available at the time of publication.

Ricardo Viana Vargas, photograph and biography not available at the time of publication.

Jeferson Carvalho Alvarenga, photograph and biography not available at the time of publication.

Christine Kowal Chinelli, photograph and biography not available at the time of publication.

Mariana de Almeida Costa, photograph and biography not available at the time of publication.

Bernardo Lino de Oliveira, photograph and biography not available at the time of publication.

Assed Naked Haddad, photograph and biography not available at the time of publication.

Carlos Alberto Pereira Soares, photograph and biography not available at the time of publication.