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ORIGINAL ARTICLE

Sustainable practices index for road construction companies – a hierarchical framework

Índice de práticas sustentáveis para empresas de construção de estradas - um framework hierárquico

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Abstract: In the alignment of ESG (Environmental, Social and Governance) growing importance for investments' decisions this paper presents an index for evaluating sustainable practices of road construction companies. For assessing the sustainable practices, it was developed a hierarchical framework based on environmental, social, and economic dimensions. The practices' themes and its respective practices were found in the literature, and were selected and validate by an expert' panel. That resulted in 12 practices themes and the 37 most relevant practices to the road construction sector. For each practice it was established a set of indicators. For the sustainable practices index, the dimensions and practice's themes weights were determined using the Simplified Process Hierarchical Analysis method, applied to a second experts' panel. By linking the sustainable practices to measurable indicators, it was possible to attain an overall sustainable practices index for road construction companies. The SPC method used in this case study emphasized practices in the "social" and "environmental" dimensions, with weights of 0.459 and 0.344. The framework elaborated is practical and expeditious, which has a feasible approach to tackling main ESG issues, helping road construction companies and governments preparedness for the new demands of investors and stakeholders.

Keywords: Sustainability; Road construction; Sustainable practices; Indicators; ESG.

Resumo: No alinhamento da crescente importância ESG (Ambiental, Social e Governança) para as decisões de investimento, este artigo apresenta um índice para avaliação de práticas sustentáveis de empresas de construção de rodovias. O índice desenvolvido pode ser utilizado para auxiliar na tomada de decisões estratégicas de escolha de empresas durante a fase de licitação e / ou para autoavaliação de uma empresa. Para avaliação das práticas sustentáveis foi desenvolvido um quadro hierárquico baseado nas dimensões ambiental, social e econômica, com seus respectivos temas de práticas. Os temas de práticas e suas respectivas práticas foram encontrados na literatura e foram selecionados e validados por um painel de especialistas. Isso resultou em 12 temas de práticas e as 37 práticas mais relevantes para o setor de construção rodoviária. Para cada prática foi estabelecido um conjunto de indicadores. O método SPC utilizado neste estudo de caso enfatizou as práticas das dimensões "sociais" e "ambientais", com pesos de 0,459 e 0,344, respectivamente. A estrutura do framework elaborada é prática e ágil, com uma abordagem viável para lidar com as principais questões ESG, ajudando as construtoras de estradas e os governos a se prepararem para as novas demandas de investidores e partes interessadas.

Palavras-chave: Sustentabilidade; Construção de rodovia; Práticas sustentáveis; Indicadores; ESG.

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1 Introduction

According to Anastasiou et al. (2015), the construction sector bears a significant environmental burden due to resource extraction and waste generation. Butt et al. (2015), Rattanachot et al. (2015), and Grael et al. (2019) emphasize the need for road construction companies to plan strategies to mitigate their negative environmental and social impacts.

Consequently, the incorporation of sustainability practices in the construction sector has become an increasingly prevalent trend. This adoption is considered “a path of no return” as various stakeholders, including governments, investors, and associations, exert pressure on the civil construction sector to integrate sustainable practices into their operations (Guignot et al., 2015; Turk et al., 2016; Anthonissen et al., 2016).

Investors are also displaying greater concern for the societal value of sustainable investments in companies that prioritize environmental practices and corporate responsibility (Chipalkatti et al., 2021). The discussion surrounding environmental, social, and governance factors (ESG) has become prominent in major investment banks (Morgan, 2020).

In general, sustainable performance information serves as a means to compare an organization's performance over time. Olsthoorn et al. (2001) highlighted the lack of standardization for measuring sustainability in the early 2000s and the disconnect between diffusion means and business units. Herva et al. (2011) noted that during the first decade of the 2000s, there were few works proposing models to assess the sustainable performance of business associations. Consequently, companies faced challenges in combining business management with sustainability during this period (Kaya & Kahraman, 2011).

In comparison to other types of industries, road construction presents unique challenges and impacts on the environment. While all industries have their own set of environmental considerations, the construction of roads often involves large-scale land alteration and the disturbance of natural habitats. (Schlegel et al., 2016). Unlike some industries that can operate within contained facilities, road construction sites are itinerant and cover extensive longitudinal extensions. This aspect alone sets them apart from other segments of civil construction. The linear nature of highways means that they can significantly alter and fragment ecosystems along their paths, affecting wildlife habitats and disrupting ecological connectivity (Szpotowicz & Tóth, 2020).

Furthermore, road construction typically requires the extraction and consumption of substantial amounts of raw materials, such as aggregates and asphalt. These processes contribute to the depletion of natural resources and can result in increased carbon emissions. Additionally, the construction phase generates considerable waste, including excess materials, debris, and sediment runoff, which can have detrimental effects on nearby water bodies and aquatic ecosystems (Szpotowicz & Tóth, 2020).

In terms of aesthetics, the construction of highways can have a significant impact on the visual appeal of the surrounding environment. The presence of vast stretches of concrete and infrastructure can alter the natural landscape and potentially diminish the scenic value of an area. It is important to note that various industries have their own environmental impacts, and mitigating these impacts requires tailored approaches. However, the unique characteristics of road construction, such as the extensive land alteration, resource consumption, and potential disruption of ecosystems, necessitate specific considerations and strategies to minimize its environmental footprint and promote sustainability. By adopting environmentally conscious practices, such as incorporating green infrastructure, mitigating habitat fragmentation, and implementing

proper waste management, the negative environmental effects of road construction can be mitigated to some extent.

In last decade, new methods emerged to assess the sustainability of companies - such as GRI (2012) – *Global Reporting Initiative*, UN (2018) – *United Nations*, or the sustainability criteria of GVCes (*Center Sustainability Studies of Getulio Vargas Foundation)* Revista Exame (2018), all innovative, but none of them listed a robust system to measure sustainability and its respective practices. Also, those methods are not focused for the road construction sector. This sector differs from others and from the civil construction sector itself, as mentioned previously.

It was also verified in Brazilian legislation that government agencies do not have an effective tool to assess the sustainability of companies for a possible hiring, approval and selection of construction companies through the assessment of sustainability practices.

It is important to emphasize that sustainable management of road system construction should not only consider environmental damage through compliance with legislation but also incorporate economic and social impacts, linked to efficient business management (Schlegel et al., 2016).

Other studies present alternative techniques for assessing sustainability, such as the technique for similarity-based mathematical preference order analysis (Szpotowicz & Tóth, 2020), the Pareto concept for creating a scorecard for the indexing model that meets AHP requirements (Ibrahim & Shaker, 2019), and Life Cycle Assessment (Patel, 2020). However, none of them presented an evaluation model based on sustainable practices. It is worth noting that in recent decades, organizations have been pressured to consider, measure, and report not only the economic performance of their activities but also their environmental and social performance (Delai & Takahashi, 2011; Searcy, 2009). It is crucial to critically address the concept of sustainability in the development of highways to alleviate the impacts of global warming, resource depletion, and associated social impacts (Bujang et al., 2018). Therefore, this permeated the research question: How to assess the sustainability (ESG) of road construction companies focusing on asphalt-paved roads?

Based on the aforementioned, the GVCes criteria structure served as the starting point for developing a hierarchical framework to estimate an index of sustainable practices for road construction companies. With this in mind, a list of practices and their respective indicators for the three dimensions of sustainability (economic, social, and environmental) was developed through a literature review and expert panel. The framework was divided into four levels: the first level representing each dimension, the second level representing practice themes within each dimension, the third level representing specific practices within each practice theme, and the fourth level representing indicators for each practice. To estimate the weights for the variables in the first and second levels, a multi-criteria analysis was performed with another expert panel. Ultimately, a practical and expedient framework was achieved, offering a feasible approach to address the main ESG issues, assisting road construction companies and governments in preparing for the new demands of investors and stakeholders. By implementing the framework, road construction companies can enhance their sustainability efforts, contribute to environmental conservation, and meet the evolving expectations of investors and stakeholders in the future.

Moreover, despite the differences mentioned between road construction and other sectors, it has been found that the management tools used share similarities. Data collection methods and assessment questionnaires can be adapted. However, a distinctive element emerges in the weighting of the sustainable dimensions and

practices, facilitated by the SPC AHP method. Importantly, these weightings are not fixed; they are influenced by project complexeties and regional variations. This frameowork approach achieves a balance between adaptability and context, serving road construction needs while aligning with broader management practices.

2 Materials and methods

The elaboration of the hierarchical framework was made in two main steps. The first step consisted in an extensive a literature review on sustainability, focusing in environmental, social and economic practices and their potential indicators, having the GVCes structure as the backbone. In addition, a structured literature review was conducted according to the method proposed by Fiorini & Jabbour (2017). The keywords used in the search were: “Sustainability” and “Road System”. The search was conducted in the Scopus database in 2020, where 731 articles were identified. Those that addressed sustainability for road system construction systems totaled 30 articles. After reading those papers, the practices which can be adapted for highway construction companies were listed. Then, this list was brainstormed with 10 researchers – in the field of social responsibility (3) and environmental (3) and civil engineering (4) – to select the most relevant. A total of 12 practices themes were selected, divided in 37 practices and 117 indicators, which were the spine of the hierarchical structure of the framework. This step is described in detail in Grael (2020).

The second step was to elaborate the assessment procedure. Due to the existence of qualitative and quantitative aspects of the dimensions and practices’ themes selected; the use of a multi-criteria analysis method was employed. The method chosen was the Structured Pair-wise Comparison (SPC) used by Sharifi et al. (2006) and Taleai et al. (2007), as an alternative to the Pair-wise Comparison procedure usually employed in the AHP (Analytic Hierarchy Process) method (Saaty, 1991). The SPC can be considered a simplified AHP method. The SPC procedure consists of two steps. Initially, the criteria (dimensions and practices themes) are listed, and the respondents were asked to order those criteria by importance within the same hierarchical level (dimensions and its respective practices themes). Subsequently, the respondents should make comparisons of its importance, whether weak or strong, in relation to the subsequent criterion in the same level. For example, the respondents should compare the importance of the aspect ordered in first is weak or strong in relation to the aspect ordered in second and so on.

To apply the SPC method in this study, an online questionnaire (Table A2) was developed and distributed to an additional group of 10 specialists. Out of the 10, 8 specialists responded. These specialists were carefully selected from the fields of environmental management, environmental engineering, and highway construction. The selection criteria included possessing a PhD degree and a Scopus H-index higher than 10. This ensured a diverse range of expertise different from the specialists selected in the previous step. The composition of the respondents consisted of 50% specialists in the field of highway construction, 50% specialists in sustainability and social welfare.

So, the respondents assessed the importance of each dimension (economic, social, and environmental) and the practice themes within their respective dimensions. This process involved evaluating the dimensions against each other and subsequently considering the practice themes within each dimension. This approach allowed for weighting and aggregation, ultimately generating an index of sustainable practices for road construction companies (Stefano et al., 2015).

AHP is a highly useful method for decision-making when evaluating alternatives with multiple factors (Saaty, 1991). However, Quadros et al. (2021) argue that AHP may exhibit inconsistencies in judging certain attributes. Nevertheless, Reis et al. (2013) highlight the advantage of AHP's simplicity and wide applicability, where intuition is combined with rationality, thus mitigating potential deficiencies of the method.

The SPC method was employed for the first two hierarchical levels (dimensions and practice themes). For the third and fourth levels, which encompass the practices and their indicators, the weights were distributed uniformly based on the number of practices within each practice theme and the number of indicators within each practice. Figure 1 illustrates a schematic representation of the four hierarchical levels for the economic dimension. The weights in each level were normalized to range from 0 to 1. Consequently, the resulting sustainable practice index also falls within the range of 0 to 1. This suggestion was made by the interviewed specialists, as the weights for the first and second levels were deemed most important, while pairwise comparisons for the third and fourth levels would be impractical due to the large number of variables. Furthermore, this framework can evolve over time with the inclusion or exclusion of practices and indicators, making it a flexible tool that can be enhanced in the long run.

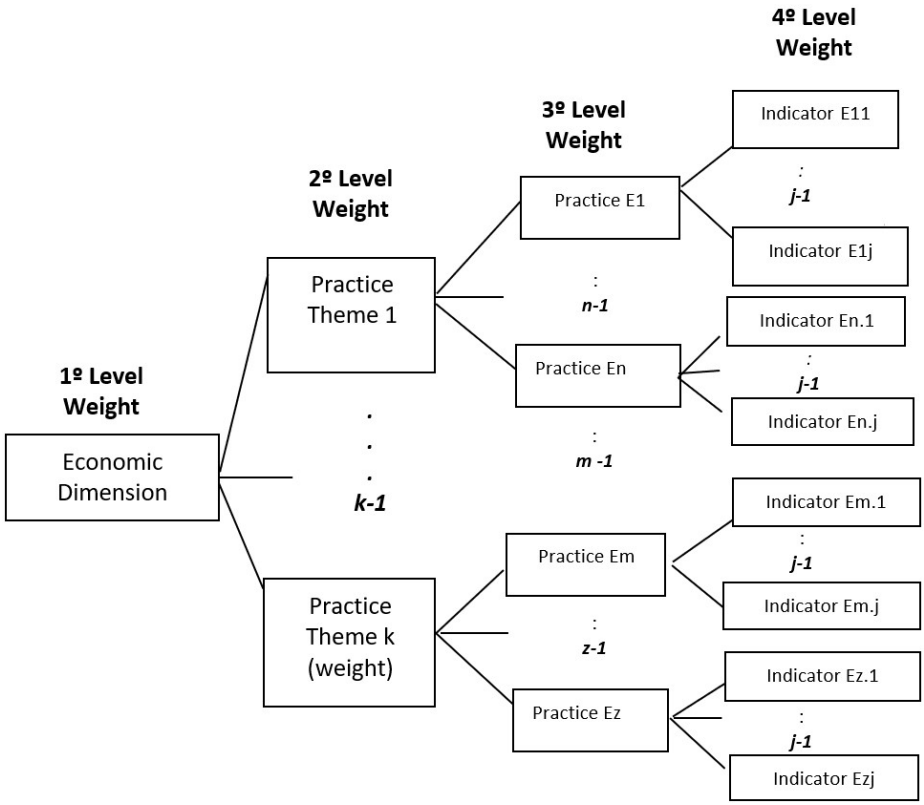

Figure 1. Example of the hierarchical framework structure for the economic dimension.

The criterion to evaluate the indicators was adapted from GVCes (Revista Exame, 2018), which elaborated a scoring criterion for measuring sustainability in companies based on levels of application of sustainability practices, namely: full application, partial application and non-application of sustainability practices. And thus, the grade of the indicator was assigned as follows:

I - Submitted sufficient documents that prove the implementation / adoption of each practice (grade: 1.0)

II - Submitted the document sufficient, but the report / document do not make it possible to ascertain whether the practice is in progress and / or is carried out properly (grade: 0.5)

III - Does not perform or adopt the practice (grade: 0)

The indicators were selected based on the ability to measure than by formal documentation.

Consequently, the sustainable practice index is calculated by the following expression (Figure 2):

$$\textbf{Grade of Practice Theme}_{\mathbf{k}} = Practice\ Theme_k weight\ * \{\Sigma\ Practice_i weight \times \left(\Sigma\ Grade\ of\ Indicator_{ij}\left[0;1\right] \times Indicator_{ij} weight\right)) = \left[0;1\right]$$

$$\textbf{Sustainable practice index} = Weight\ of\ Economic\ Dimension \times \left(\Sigma\ Grade\ of\ Practice\ Theme_k in\ Economic\ Dimension\right) + Weight\ of\ Social\ Dimension \times \left(\Sigma\ Grade\ of\ Practice\ Theme_k in\ Social\ Dimension\right) + Weight\ of\ Environmental\ Dimension \times \left(\Sigma\ Grade\ of\ Practice\ Theme_k in\ Environmental\ Dimension\right) = \left[0;1\right]$$

Figure 2. Expression.

Where: “k” is the practice theme, “i” is the number of the practice under analysis in practice theme k and “j” is the i-th indicator of practice “i”.

With the sustainable practice index, it was a suggested an assessment of this index using the range values presented in Table 1, which was adapted from the sustainability index proposed by Rabelo e Lima (2012). Thus, through from the intervals in Table 1, it is possible to classify the company’ sustainable practice index into five levels.

Table 1. Assessment of sustainable practice index.

Assessment	Legend	Sustainable practice index
Excellent	**Green**	1 ≤ IS ≤ 0.800
Good	**Blue**	0.799 ≤ IS ≤ 0.650
Average	**Yellow**	0.649 ≤ IS ≤ 0.500
Bad	**Pink**	0.499 ≤ IS ≤ 0.300
Critical	**Red**	0.209 ≤ IS ≤ 0.000

Source: Adaptad from Rabelo & Lima (2012).

In the next section it will be presented a brief description of the theoretical background for the practices and indicators selected in this study.

3 Theoretical framework

According to Muchiri et al. (2011) measuring the performance of a business is a fundamental principle for effective management. This measurement takes place through assessments of indicators, which if well defined can identify problems, diagnose its causes and propose solutions. It is important to emphasize that performance measurement has an important link between strategy and action management to implement improvements.

The strategy for achieving sustainable performance comprises a set of activities aimed at improving the environmental, economic and social aspects of the business, allowing stakeholders to make the right choices and the best decisions. However, the challenge is to select the most appropriate strategy for organizations (Iritani et al, 2015), and in this sense, the GRI (2012) highlights the need to build a sustainability assessment system.

In 2018, the UN presented 17 Sustainable Development Goals (SDGs) to ensure the human rights of all. The SDGs are integrated and indivisible, and mix, in a balanced way, the three dimensions of sustainable development: the economic, social and environmental for 2030 (UN, 2018).

It is important to emphasize that methods of sustainability assessment should involve the stakeholders, identify the means of assessment with widespread application and be relevant for most organizations (GRI, 2012, Santos et al., 2017). However, there is a lack of a standard methodology accepted globally and there are discrepancies among sustainability indexes and for ESG factors. In this way, there is no standardization for sustainability or ESG issues, and some can be delineated in distinct approaches based on the industry, company characteristics, and the business model. For example, the term diversity can be described as a social or governance issue depends on ESG analyst's perspective, where governance is entangled with social and economic aspects. Nevertheless, the main topics are related to social, environmental and economic subjects. Billio et al. (2021) highlight the need for policy makers and regulators to adapt common practices and rules for reporting sustainable indicators. They emphasize that such adaptations should be considered to ensure effectiveness. Additionally, Gyönyörová et al. (2021) demonstrate that the validity of ESG data and scores varies depending on the industry type and locations. This finding underscores the importance of incorporating these aspects into decision analysis processes.

The role of companies is crucial in achieving the Sustainable Development Goals (SDGs). To support this endeavor, Exame Magazine collaborated with the Center for Sustainability Studies of the Getulio Vargas Foundation of São Paulo (GVCes) to develop a methodology called the "Exame Sustainability Guide" (Revista Exame, 2018). This guide represents one of the largest surveys of corporate responsibility practices in Brazil to date, encompassing ten themes: Human Rights, Ethics and Transparency, Water Management, Biodiversity Management, Supplier Management, Waste Management, Sustainability Governance, Climate Change, Community Relations, and Customer Relations. We utilized this methodology as our starting point for selecting key sustainable practices.

4 Results

Initially, for selecting the sustainability practices in the road construction sector, they were divided in the three sustainability dimensions (economic, social and environmental). This division was based on the following main works: Veleva & Ellenbecker (2001), GRI (2012), ABNT ISO (1999) and the GVCes (Revista Exame, 2018) of Fundação Getúlio Vargas. Based on these references, for each sustainability dimension (economic, social and environmental) the practices themes were subdivided according to Table 2.

A bibliographic research was conducted to analyze the themes of sustainability practices (environmental, social, and economic) and road construction. In addition to researching the Scopus database, these studies examined the theoretical frameworks of other works, particularly the GRI guidelines (GRI, 2012), United Nations (UN, 2018),

and Revista Exame (2018). A list of practices was generated from the literature and discussed with 10 specialists to identify the most relevant practices for the sector along with their respective indicators. The selection criterion for these practices was based on the potential to consistently contribute to meeting the objectives of each practice, as presented in Table 2.

Table 2. Practices Themes and objectives.

Dimension	Practices Themes	Practices Themes' Objectives
Economic	Sustainable strategic investment planning	Strategic objectives
		Quantification of social and environmental aspects
	Risk and Opportunities	Relation of risks and opportunities with social and environmental aspects
	Investment performance management	Performance management system
		Results presentation
	Crises and contingency plans	Crisis Contingency Procedures
		Measurement of Result Indicators
Social	Diversity	Eradication of poverty, social enhancement, inclusion
	Professional development	Ensure education and development
		Meeting competency requirements
	Supplier management	Social criteria for selecting and monitoring third-party suppliers and information
	Social investment	Social investment policy
		Promotion of social initiatives
Environmental	Environmental Management	Strategic objectives
		Assess and monitor environmental performance
	Waste Generation	Manage environmental liabilities
		Map environmental aspects and impacts
	Natural resources consumption	Natural resources consumption
		Waste generation
	Atmospheric emissions, liquid effluents and waste	Waste management plan

In this research, only indicators that could be analyzed through documents were chosen. Table A1 in the Appendix presents all 37 practices along with their respective indicators selected for this study, along with the literature source for each. A brief description of the characteristics of the indicators within the practice dimensions (economic, social, and environmental) is provided as follows.

4.1 Indicators for economic practices

Economic indicators, in the sustainability economy, are important to the organization's impacts on the living conditions of its necessary parts and on economic systems at local, national and global levels. The economic indicators illustrate (GRI, 2012):

• The flow of capital between the different defined parties.

• The main economic impacts of the organization on society.

4.2 Indicators for social practices

The indicators for social practices identified aspects regarding labor practices, human rights, society and corporate social responsibility (GRI, 2012; Sen, 2007; UN, 2018), with a view to seeking the following benefits:

• Develop the local economy through job and income generation.

• Generate benefits through taxes paid.

• Promote the positive integration of the community to which it is inserted.

• Seek the implementation of adequate labor practices and human rights.

4.3 Indicators for environmental practices

The indicators for environmental' practices identified aspects that can be translated into economic gains, with cost reduction through better use of resources, operation and maintenance of buildings (GRI, 2012; Veleva & Ellenbecker, 2001; ISO 14031, 1999) and should also encompass performance regarding:

• Consumption of raw materials.

• Energy and water consumption.

• Reduction of emissions, effluents and waste.

Analyzing the weights obtained from the applied hierarchical method, a greater relevance was observed between the "social" and "environmental" dimensions, obtained a weight of 0.459 and 0.344, respectively. This result shows a paradigm shift in relation to the economic dimension (weight of 0.197), which has always been observed to determine business success, as pointed out by Veleva & Ellenbecker (2001) and Grael & Bezerra, (2017). This shift is in alignment with the ESG and SDGs agenda. Also, it was possible to observed that the indicators that related the themes: "management", "planning" and "development" were preferred by the specialists, showing the importance of management, planning and development to achieve sustainable performance and survey of impacts and sustainable aspects (GRI, 2012; Nogueira, 2011). For economic' dimension the practice themes "Sustainable Strategic Planning"; and "Risks and Opportunities" received a weight of 0.307% each. For social' dimensions the practice theme related to "Professional social development" had a weight of 0.384. For environmental' dimension the practice theme "Environmental Management" received a weight of 0.452.

Table 1 illustrates the framework for qualitative assessment of a sustainable practice index, according to weights of the dimensions and theme practices obtained by the SPC method, and the practices themes and their respective indicators weights. This Table 3 can also be used as a tool for selecting construction companies (approval criteria) for companies in the road construction sector.

It's important to emphasize that the construction of highways entails distinct factors compared to other organizations. This distinction is evident in the results of the SPC AHP research, where the social aspect takes on heightened importance with a weight of 0.459. This prominence is primarily attributed to the industry's itinerant nature, which can impede certain engagement and labor management processes. Following this is the environmental aspect, holding a weight of 0.344.

Evaluating sustainability practices within the pillars, the economic dimension, although bearing a weight of 0.197, encompasses practices like Sustainable Strategic Investment Planning (involving sustainable goal-setting, quantification of financially sustainable aspects, and sustainable synergy) and Risk and Opportunities (covering

sustainable risk and opportunity management, along with research related to negative economic impacts), each carrying a weight of 0.307.

Table 3. Framework for Sustainable practices Index.

Dimension	Practice Theme (K)	Practice Theme Weight	Practice (i)	Practice Weight	Indicator (ij)	Indicator Weight (ij)
Economic	Sustainable strategic investment planning (1)	0.307	E1	0.33	E.1.1	0.33
					E.1.2	0.33
					E.1.3	0.33
			E.2	0.33	E.2.1	0.20
					E.2.2	0.20
					E.2.3	0.20
					E.2.4	0.20
					E.2.5	0.20
			E.3	0.33	E.3.1	0.33
					E.3.2	0.33
					E.3.3	0.33
Weight (0.197)	Risk and Opportunities (2)	0.307	E.4	0.50	E.4.1	0.33
					E.4.2	0.33
					E.4.3	0.33
			E.5	0.50	E.5.1	0.50
					E.5.2	0.50
	Investment performance management (3)	0.241	E.6	0.50	E.6.1	0.33
					E.6.2	0.33
					E.6.3	0.33
			E.7	0.50	E.7.1	0.33
					E.7.2	0.33
					E.7.3	0.33
	Crises and contingency plans (4)	0.145	E.8	0.50	E.8.1	1.00
			E.9	0.50	E.9.1	1.00
Social	Diversity (5)	0.384	S.1	0.125	S.1.1	0.20
					S.1.2	0.20
					S.1.3	0.20
					S.1.4	0.20
					S.1.5	0.20
			S.2	0.125	S.2.1	0.25
					S.2.2	0.25
					S.2.3	0.25
					S.2.4	0.25
			S.3	0.125	S.3.1	0.20
					S.3.2	0.20
					S.3.3	0.20
					S.3.4	0.20
					S.3.5	0.20
			S.4	0.125	S.4.1	0.33
					S.4.2	0.33
					S.4.3	0.33
			S.5	0.125	S.5.1	0.25
					S.5.2	0.25
					S.5.3	0.25
					S.5.4	0.25
			S.6	0.125	S.6.1	0.33
					S.6.2	0.33
					S.6.3	0.33
			S.7	0.125	S.7.1	0.50
					S.7.2	0.50
			S.8	0.125	S.8.1	0.20
					S.8.2	0.20
					S.8.3	0.20
					S.8.4	0.20
					S.8.5	0.20

Table 3. Continued...

Dimension	Practice Theme (K)	Practice Theme Weight	Practice (i)	Practice Weight	Indicator (ij)	Indicator Weight (ij)
Weight (0.459)	Professional development (6)	0.156	S.9	0.50	S.9.1	0.50
					S.9.2	0.50
			S.10	0.50	S.10.1	0.50
					S.10.2	0.50
	Supplier management (7)	0.312	S.11	0.25	S.11.1	0.33
					S.11.2	0.33
					S.11.3	0.33
			S.12	0.25	S.12.1	0.20
					S.12.2	0.20
					S.12.3	0.20
					S.12.4	0.20
					S.12.5	0.20
			S.13	0.25	S.13.1	0.50
					S.13.2	0.50
	Supplier management (7) Continuation	0.312	S.14	0.25	S.14.1	0.25
					S.14.2	0.25
					S.14.3	0.25
					S.14.4	0.25
Social	Social investment (8)	0.147	S.15	0.33	S.15.1	0.25
					S.15.2	0.25
					S.15.3	0.25
					S.15.4	0.25
Weight (0.459)			S.16	0.33	S.16.1	0.50
					S.16.2	0.50
			S.17	0.33	S.17.1	0.20
					S.17.2	0.20
					S.17.3	0.20
					S.17.4	0.20
					S.17.5	0.20
Ambiental	Environmental Management (9)	0.452	A.1	0.33	A.1.1	0.20
					A.1.2	0.20
					A.1.3	0.20
					A.1.4	0.20
					A.1.5	0.20
			A.2	0.33	A.2.1	1.00
			A.3	0.33	A.3.1	0.25
					A.3.2	0.25
					A.3.3	0.33
					A.3.4	0.25
	Waste Generation (10)	0.171	A.4	0.50	A.4.1	0.33
					A.4.2	0.33
			A.5	0.50	A.5.1	0.25
					A.5.2	0.25
					A.5.3	0.25
					A.5.4	0.25
Weight (0.344)	Natural resources consumption (11)	0.226	A.6	0.25	A.6.1	0.50
					A.6.2	0.50
			A.7	0.25	A.7.1	1.00
			A.8	0.25	A.8.1	0.50
					A.8.2	0.50
			A.9	0.25	A.9.1	0.20
					A.9.2	0.20
					A.9.3	0.20
					A.9.4	0.20
					A.9.5	0.20
	Atmospheric emissions, liquid effluents and waste (12)	0.151	A.10	0.50	A.10.1	0.50
					A.10.2	0.50
			A.11	0.50	A.11.1	0.33
					A.11.2	0.33
					A.11.3	0.33

In the same evaluation, the social dimension carries the greatest weight (0.459). Within this dimension, Diversity practices (0.384) – which include establishing committees for eradicating any form of diversity and providing channels for reporting adverse practices – and Supplier Management (0.312) – encompassing qualification criteria and social engagement of suppliers, coupled with measures to improve diversity – hold the highest weights.

In the environmental dimension, the most significant weight in the evaluation pertains to Environmental Management (0.452). This practice encompasses the implementation of environmental management systems, awareness training, and structured environmental programs.

The tools used for management are applicable across various types of organizations. Consequently, data collection surveys and practice evaluations can be adapted for use in different sectors. The variable that may differ is the weight assigned to the pillars in the SPC AHP method. These weight variations stem from the unique aspects of itinerant construction projects, coupled with regional social, environmental, and economic disparities.

The significance of the sustainable practice index is strongly influenced by the weights attributed to both dimensions and practices. Within this context, the values listed in Table 1 serve as a diagnostic tool, aiding in the recognition of practices that have the potential for adoption or enhancement. As a prospective avenue for further investigation, it's advisable to undertake a sensitivity analysis that delves into the impact of practice theme weights on the sustainable practice index.

5 Conclusions

Although the construction of a road system has several positive aspects, such as improved mobility, job generation, and economic development, it also entails negative aspects associated with high raw material consumption, waste generation, and economic, financial, and social implications.

In light of this panorama, this research has resulted in the development of a sustainable practice index using an assessment framework. This index can serve as a tool for selecting road construction companies in public bidding processes. By incorporating this framework, public agencies can enhance the bidding process by considering not only the best price and technique criteria but also the best sustainable practices index criteria, in addition to fulfilling legal requirements.

The sustainable practices index framework offers a useful, balanced, and reasonable means of assessing the level of sustainable practices within the road construction sector. The practices and indicators presented in Table A1 (Appendix) can serve as a guide for incorporating sustainable management into company practices, supporting strategic decision-making processes aimed at achieving sustainable performance.

It is noteworthy that road construction involves distinctive factors compared to other organizations. However, the management tools share similarities with those of other industries. Data collection questionnaires and practice evaluations can be adapted for use in different sectors. The only variable that might differ is the weight attributed to the pillars, as determined by the SPC AHP method. These weights could change due to the specificities of itinerant construction projects, as well as regional variations in social, environmental, and economic aspects.

It is worth emphasizing that the SPC method applied in this study assigns significant weight to the “social” (0.459) and “environmental” (0.344) dimensions.

For future research, it is suggested to apply this sustainable practice index in a case study involving companies in the sector. This case study would enhance the analysis of company selection in bidding processes and validate the index, while also facilitating the development of sustainability standards, objectives, and targets for the sector in alignment with ESG demands from investors. Additionally, alternative hierarchical methods or sensitivity analysis could be employed to estimate the weights, addressing any potential criticisms that may arise from the AHP method.

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Authors contribution

Paulo Fernando Fuzer Grael was responsible for planning the experiment together with the supervisor and collaborator, for carrying out the research, analysis, interpretation and writing of the text and preparing the aforementioned manuscript for publication. Barbara Stolte Bezerra was also responsible for planning and guiding the execution and preparation of the work. Rosane Aparecida G. Battistelle worked as a collaborator in the research group, participating in planning and supporting the preparation of the document.

Appendix 1. Sustainable practices and respective indicators

Table A1. Sustainable practices and respective indicators.

ECONOMIC PRACTICES	PRACTICE INDICATOR
E.1 - Contemplate the social and environmental objectives in strategic planning	E.1.1 - Development of products and services (beyond the minimum required by law) that contribute to increasing social inclusion and reducing poverty (UNEP/SETAC, 2007; Huang et al., 2013)
	E.1.2 - Creation of social value, through a value proposition that is not limited to serving the poorest populations, but also acting in other market segments (Sommerrock, 2010; Prahalad & Hart 2002; Porter & Kramer, 2006)
	E.1.3 - Creating value for the different audiences with which the company's relationships (ILCD, 2010; Revista Exame, 2018; Santos et al., 2019).
E.2 - Quantify social and environmental aspects in financial projections	E.2.1 - More efficient use of natural resources to reduce economic costs and environmental impacts (UNEP/SETAC, 2007; Giustozzi et al., 2012).
	E.2.2 - Reduction of the negative impacts of operations in its value chain (ILCD, 2010; Kahneman, 2012).
	E.2.4 - incorporate more sustainable processes into their activities, generating additional value for their business (Austin el al., 2006)
	E.2.5 - Investments and development of opportunities related to climate change and the green economy. (GRI-ROI, 2017).
E.3 - Assess social and environmental impacts (positive and negative) and identify synergistic alternatives with sustainability	E.3.1 – Review the business plan, aiming to assess its social and environmental impacts, objectives and goals, in addition to identifying alternatives in line with sustainability (Revista Exame, 2018; CEBDS, 2018)
	E.3.2 – Undertake the company's management aiming at sustainable actions (Santana & Souza 2015; Fischer & Comini, 2012)
E.4 - Corporate risk and opportunity management process that considers issues short, medium and long term socio-environmental	E.4.1 - Corporate risk management that considers in an integrated way: economic, social and environmental impacts, aiming at mitigating and/or eliminating strategic risks (Revista Exame, 2018)
	E.4.2 – Financial risk analysis (market, credit, liquidity) (Revista Exame, 2018)
	E.4.3 - Legal or regulatory risk analysis (Revista Exame, 2018; GRI-ROI, 2017)
E.5 - Survey and characterization of the management of the organization's negative economic impacts	E.5.1 - Implement processes and procedures for opportunity management considering short, medium and long term socio-environmental aspects (Attallah, 2013)
	E.5.2 - Seek innovative alternatives that preserve or generate value for the company, the environment and society (Oltean-Dumbrava et al., 2014).
E.6 – Adopt a performance management system based on indicators and publish its financial statements	E.6.1 – Develop economic goals for growth, investment and innovation (Schlange, 2006; Strauss et al., 2018)
	E.6.2 - Include the impacts and gains generated to the society and the environment in the profitability for its shareholders (Slaper & Hall, 2011).
	E.6.3 - Use indicators as a management tool and internally disseminate/publish these values (GRI-ROI, 2017; Santos et al., 2019)
E.7 - Measures to generate economic value to assess the adequacy of the level of activity (revenues) and legal compliance in compliance with accounting and financial legislation	E.7.1 - Prepare and publish monetarily updated of financial statements (GRI-ROI, 2017)
	E.7.2 - Calculate economic profit or other measures of economic value generation (Revista Exame, 2018; Attallah, 2013)
	E.7.3 - Bear in mind that economic profit is not accounting profit, but the result obtained after deducting the cost of all invested capital. (Porter & Kramer, 2006)
E.8 - Contingency plan to manage crises during project execution	E.8.1 - Generation of a risk spreadsheet that includes all risks arising from different crises (in economic, social and environmental areas) - (Revista Exame, 2018)
E.9 - Insurance coverage, in addition to project or enterprise risk coverage	E.9.1 - Operational risks (Risks covered by an all-risk insurance policy, in which only exclusions from coverage are listed): general liability, natural disasters, fraud and loss of profit or loss of revenue (Revista Exame, 2018)
SOCIAL PRACTICES	PRACTICE INDICATOR
S.1 - Formal commitment to the eradication of child labor and specific program for hiring apprentices to	S.1.1 - Formal commitment to the eradication of child labor, through: a formalized Code of Conduct; Corporate Policy that addresses the topic (approved by senior management and establishing guidelines for management; Formal adherence of employees to voluntary initiatives to seek the eradication of theme (Revista Exame, 2018; UNEP/SETAC, 2007);

Table A1. Continued...

ECONOMIC PRACTICES	PRACTICE INDICATOR
meet the minimum required by law	Seek preventive action in potential situations that characterize child labor in all its operations (UN, 2018),
	S.1.2 - Systematic communication of the commitment to ending the eradication of child labor to all stakeholders. (UN, 2018; CEBDS, 2018).
	S.1.3 - It provides a reporting channel and a process for investigating and responding to reports involving child labor in the company or in its supply chain (Revista Exame, 2018)
	S.1.4 - Create programs for hiring apprentices, and offer: Technical training for apprentices in their specific area of expertise; Promoting the learner's autonomy, planning capacity and creativity; Recruitment and hiring with low-income communities, close to the company's facilities; Recruiting and hiring through organizations active in youth development; Adoption of permanent or professional referral plans (Revista Exame, 2018)
	S.1.5 - Comply with the percentage quota of apprentices hired in the company of at least 5% and at most 15% of workers per location, pursuant to Law 10,097, of 12/19/2000, Art. 429 and its regulations, Decree 5.598/2005 Revista Exame, 2018
S.2 - Formal commitment to the eradication of forced or compulsory labor	S.2.1 - Formal commitment to the eradication of forced or compulsory labor, through: Formalized code of conduct; Corporate policy addressing the topic (approved by senior management and establishing management guidelines) ; Formal adherence to voluntary initiatives (Revista Exame, 2018; UNEP/SETAC, 2007)
	S.2.2 - Systematic communication of the commitment to eradicate forced labor to all stakeholders, and include it in all operations of the company and its supply chain (UN, 2018).
	S.2.3 - Create an awareness program for the internal public about the risk of the company's involvement with forced or compulsory labor (Revista Exame, 2018)
	S.2.4 - Provide a channel for complaints and a process for investigating and responding to these complaints involving this type of work in the company and in its supply chain (Revista Exame, 2018)
S.3 - Formal commitment to valuing diversity and processes, and implemented procedures aimed at valuing diversity in terms of employment and occupation	S.3.1 - Formal commitment to the eradication of all forms of discrimination, through: Formalized Code of Conduct; corporate policy that addresses the topic (approved by senior management and establishing management guidelines); Formal adherence to voluntary initiatives; Eliminate diversity-related discrimination in: Selection and hiring: Compensation; Promotion; Access to training; Sensitization of direct employees and outsourced workers on the subject. (Revista Exame, 2018)
	S.3.2 - Establishing jobs for the disabled (Schlange, 2006)
	S.3.3- Seek preventive actions in situations that characterize the discrimination of diversity in all its operations and monitor diversity in the company, developing activities to value groups that are poorly represented in the company. (UNEP/SETAC, 2007)
	S.3.4 - Contemplate the diversity theme in all the company's operations and its supply chain and carry out the systematic communication of the commitment to diversity to all stakeholders (UN, 2018)
	S.3.5 - Provide a channel for complaints and a process to investigate and respond to these complaints involving diversity in the company and its supply chain (Revista Exame, 2018)
SOCIAL PRACTICES	PRACTICE INDICATOR
S.4 - Participation of women and blacks in the staff	S.4.1 - Formal commitment to the participation of women and afro-descendants in the company's staff, through: Formalized code of conduct; Corporate policy addressing the topic (approved by senior management and establishing management guidelines); Formal adherence to voluntary initiatives (Revista Exame, 2018)
	S.4.2 - Systematic communication of the commitment to the participation of women and blacks in the company's staff to all stakeholders (Revista Exame, 2018)
	S.4.3 - Internal public awareness program on the participation of women and afro-descendants in the company's workforce (Revista Exame, 2018)
S.5 - Formal commitment to combat moral harassment (verbal, physical,	S.5.1 - Formal commitment to combat moral harassment (verbal, physical, psychological) and sexual harassment, through: Formalized code of conduct; Corporate policy addressing the topic (approved by senior

Table A1. Continued...

ECONOMIC PRACTICES	PRACTICE INDICATOR
psychological violence) and sexual harassment	management and establishing management guidelines) and Formal adherence to voluntary initiatives (Revista Exame, 2018)
	S.5.2 - Contemplate the eradication of bullying in all company operations and its supply chain (Revista Exame, 2018)
	S.5.3 - Systematic communication of the commitment to eradicate all forms of harassment to all stakeholders (Revista Exame, 2018)
	S.5.4 - Provision of a reporting channel and a process for investigating and responding to these reports involving all types of harassment in the company and its supply chain (Revista Exame, 2018)
S.6 -Implemented processes and procedures for communication and dialogue that seek to receive, register, respond to and clarify all criticisms and suggestions.	S.6.1 - Implemented processes and procedures for communication and dialogue that seek to receive, register, respond to and clarify all criticisms and suggestions or complaints regarding compliance with its code of conduct, for the internal public and other interested parties, and respond to them when applicable (Revista Exame, 2018)
	S.6.2 -Have a code of ethics and have a guidance and training program for employees at all hierarchical levels to ensure that values and principles are incorporated into work processes and people's attitudes and behavio. (Revista Exame, 2018)
	S.6.3 -Have a consolidated communication channel with unions, informing them and providing them with financial and strategic objectives data to support discussions with transparent information. (Schlange, 2006)
S.7 - Compensation policy that guarantees employees and their families an adequate standard of living	S.7.1 - Have a remuneration policy that guarantees employees and their families an adequate standard of living (Revista Exame, 2018)
	S.7.2 - Seek to reduce the distance between the highest and lowest remuneration paid by the company, contributing to an economically fairer society (Uteng et al., 2019), and contemplate carrying out a survey to measure employee satisfaction regarding the compensation and benefits policy offered by the company (Revista Exame, 2018).
S.8 - Formal commitment to free union association and the right to collective bargaining, and implemented processes and procedures that ensure labor rights in the workforce	S.8.1 - Formal commitment to free union association, through: Formalized Code of Conduct; Corporate policy addressing the topic (approved by senior management and establishing management guidelines); Formal adherence to voluntary initiatives; encourages and ensures the exercise of these rights in all company operations (Revista Exame, 2018)
	S.8.2 - Implemented processes and procedures that ensure employees' labor rights (Revista Exame, 2018)
	S.8.3 - Communicate employees of their rights and ensure that exercising them does not result in negative consequence (Revista Exame, 2018)
	S.8.4 - Offer safe conditions and health programs for employees (Schlange, 2006)
	S.8.5 – Contemplate an open agenda for dialogue, regardless of collective bargaining and the base date defined by the government and/or employee representation entities (Revista Exame, 2018)
SOCIAL PRACTICES	PRACTICE INDICATOR
S.9 - Ensure access of all employees to education and development activities that enhance competence, career opportunities and employability, regardless of their hierarchical level	S.9.1 -Develop a diagnosis of potential skills to be developed in-house education, training and skills development activities, with rewards and continuous improvement of all its staff, considering the applicability in their current role, (Parmigiani et al.; 2011; (Revista Exame, 2018; Schlange, 2006)
	S.9.2 - Create and offer scholarships, regardless of application in your current role (Revista Exame, 2018).
S.10 - Ensure fair treatment and working conditions between employees and outsourced workers, including in the ethical conduct manual of the project and/or enterprise	S.10.1 -,Ensure equal treatment and working conditions between employees and outsourced workers, in addition to raising awareness on the issue of equity and using indicators to identify problem areas (Revista Exame, 2018)
	S.10.2 - Promote equity in the remuneration of outsourced workers and employees who perform equivalent functions (UN, 2018)
S.11 - Social criteria for qualification, selection and monitoring of its suppliers of goods and services	S.11.1- Encourage the hiring of local suppliers (UNEP/SETAC, 2007; UN, 2018);
	S.11.2 - Encourage the hiring of small and medium suppliers; (Schlange, 2006)
	S.11.3- Make timely and correct payment of the obligations of subcontracted suppliers (Schlange, 2006)

Table A1. Continued...

ECONOMIC PRACTICES	PRACTICE INDICATOR
S.12 - Eradication of child labor and forced or compulsory labor by the supplier, and procedure adopted by the company for not hiring suppliers proven to be involved in child labor and/or forced or compulsory labor	S.12.1 - Supplier awareness and monitoring program on the risk of involvement with child labor (UN, 2018; Revista Exame, 2018; CEBDS, 2018)
	S.12.2 - Supplier awareness and monitoring program on the risk of active or passive involvement with forced or compulsory labor (UNEP/SETAC, 2007; CEBDS, 2018)
	S.12.3 - Maintain an ethical conduct manual that expressly prohibits the use of illegal practices (environmental and social) to obtain commercial advantages (UN, 2018)
	S.12.4 - Investigation and responses to public allegations of situations involving child labor at the respective suppliers (UNEP/SETAC, 2007)
	S.12.5 - Investigation and responses to public allegations of situations involving forced or compulsory labor at its suppliers (UNEP/SETAC, 2007)
S.13 - Engagement of its suppliers in relation to medium and long-term aspects related to the business	S.13.1 -Have selection and evaluation policies for suppliers and partners known to the parties involved and not based only on factors such as quality, price and deadline. But with known standards for the selection and evaluation of suppliers that include criteria and requirements related to compliance with labor, social security and tax legislation, in addition to basic criteria for respecting the legislation, specific criteria for social responsibility, and the adoption of environmental standards. (Revista Exame, 2018)
	S.13.2 - Establish sanctions for suppliers in cases of failure to apply sustainability policies (Revista Exame, 2018).
S.14 - Corporate policy that prevents the use of third-party information (customers, suppliers, partners) without their formal and previously granted authorization	S.14.1 - Corporate policy that prevents the use of third-party information (customers, suppliers, partners) without their formal and previously granted authorization (Revista Exame, 2018)
	S.14.2 - Provide guidelines and procedures for the areas responsible for collecting, storing and analyzing data from suppliers, such as registration data, confidential information, and requirements of signed contracts (Revista Exame, 2018)
	S.14.3 - Establish external audit processes to assess the effectiveness of established security systems to prevent access or misappropriation of information by third parties (UNEP/SETAC, 2007)
	S.14.4 - Provision of simple and effective means for the consumer to request the interruption in the use of their data (Uteng et al.,2019)
SOCIAL PRACTICES	PRACTICE INDICATOR
S.15 Corporate policy that addresses the issue of private social investment, promote private social investment initiatives, such as non-voluntary social investments for the entire company	S.15.1 Corporate policy that addresses the topic of private social investment in the company's strategic planning (GRI, 2012)
	S.15.2 Contribute to the construction and participatory dialogue in the implementation of public policies and/or collective agendas of sustainable development, in addition to participating in councils and committees (or similar) to debate local development (Revista Exame, 2018; CEBDS, 2018; UN, 2018)
	S.15.3 - Establish follow-up indicators for established goals, monitor, evaluate and communicate results on social investments and clearly define the strategy, indicators and specific goals for social investment (CEBDS, 2018)
	S.15.4 - Social investment policy available in the free access area of the company's website (Revista Exame, 2018)
S.16 - Encourage volunteering through a structured program, including monitoring and evaluation steps, respecting the skills and wishes of the employee	S.16.1 - Encourage volunteering through a structured program, including monitoring and evaluation steps, (UN, 2018)
	S.16.2 In volunteer actions: Regularly evaluate the results; Adopt transparency practices regarding the actions and resources employed; Conduct consultations with relevant stakeholders to define investment priorities (UN, 2018; CEBDS, 2018)
S.17 - Corporate policy that addresses the issue of relationship with the local community, and participate in efforts to prepare public policies through proposals or formal positions	S.17.1 - Develop corporate policy that addresses the issue of relationship with the local community and exchange experiences with cultural activities of the regional/local economy. (Schlange, 2006; UN, 2018)
	S.17.2 - Ensuring that community complaints are responded to and properly managed by mapping, identifying and evaluating the risks and impacts generated in the community resulting from the company's activities (CEBDS, 2018; UN, 2018)
	S.17.3 - Ensure that relevant social information is disclosed and disseminated in an open access area of the company's website (UN, 2018)

Table A1. Continued...

ECONOMIC PRACTICES	PRACTICE INDICATOR
	S.17.4 - Seek remedial measures in response to community complaints and manifestations and have a structured process for registering complaints and promoting systematic meetings to inform local leaders about measures taken (Revista Exame, 2018)
	S.17.5 - Have a formal policy to anticipate community demands and inform them about current and future impact plans for their activities, and involve the community in problem solving (UN, 2018)
ENVIRONMENTAL PRACTICES	PRACTICE INDICATOR
A.1 - Corporate policy that contemplates environmental aspects whose guidelines are reflected in its management and planning processes in all company units; Formal and effectively implemented environmental risk communication program; and environmental licensing of its projects, facilities and operations	A.1.1 - Actions to mitigate greenhouse gas emissions, protection and/or conservation of biodiversity (CEBDS, 2018)
	A.1.2 - Prevention of pollution and environmental impacts arising from its facilities and operations (ISO 14031, 1999)
	A.1.3 - Strictly comply with the parameters and requirements required by national legislation, developing internal environmental improvement programs, prioritizing preventive policies and having an area or committee responsible for the environment (Muchiri et al., 2011, ISO 14031, 1999)
	A.1.4 - Treating the environmental issue as a cross-cutting theme in its organizational structure includes it in strategic planning. (ISO 14031, 1999)
	A.1.5 - Adopt a structured program for the dissemination, mobilization, training and monitoring of knowledge and adherence of employees to the environmental policy and disseminate it through administrative documents, such as notices, contracts and commercial proposals (ISO 14031, 1999)
A.2 - Training aimed at employees and third parties on environmental aspects and impacts	A.2.1 - Evaluation of employees that explicitly consider the company's environmental performance and verification of the level of knowledge and commitment of the internal public in relation to the corporate environmental policy (CEBDS, 2018)
A.3 - Structured programs for managing your environmental performance, and periodically publishing your environmental performance	A.3.1 - Develop business models considering, from inception, the principles and opportunities related to environmental sustainability (Iritani, Silva, Saavedra, Grael e Ometto, 2015, Huang et al., 2013; ISO 14031, 1999).
	A.3.2 – Measure environmental performance and create goals to mitigate significant risks and use of natural resources (Schlange, 2006)
	A.3.3 - Require environmental legal compliance for critical suppliers, in addition to instigating actions to improve environmental performance for them (UNEP/SETAC, 2007; ILCD, 2010; CEBDS, 2018)
	A.3.4 – Develop documented and implemented procedures that guide the execution of operations with potential environmental impacts (ISO 14031, 1999)
ENVIRONMENTAL PRACTICEs	PRACTICE INDICATOR
A.4 - Study of impacts and environmental aspects of its products (goods or services), and Permanent Preservation Areas (APP) and Legal Reserve on its properties or properties belonging to third parties	A.4.1 - Plan, develop and implement industrial processes and technologies that minimize or eliminate waste, reduce waste, and provide safe operations and seek to develop products that are recyclable, or can be remanufactured or reused (Butt et al., 2015; CEBDS, 2018)
	A.4.2 -Produce environmental impact studies of the processes and supply chain, as required by legislation and focus its preventive action on processes that offer potential damage to the health and safety of its employees, in addition to complying with the legal obligation. (Santos et al., 2017; Butt et al., 2015; ILCD, 2010)
	A.4.3 - Know and develop actions to prevent the main environmental impacts caused by its processes and products or services, and regularly carry out control and monitoring activities (Santos et al., 2019; ISO 14031, 1999)
A.5 Actions developed by the company in favor of the conservation and sustainable use of biodiversity and ecosystem services	A.5.1 - Develop actions and promote the conservation of the use of sustainability and dissemination of the corporate policy that addresses its environmental aspects (Revista Exame, 2018)
	A.5.2 - Carry out a campaign to publicize environmental protection with the preparation and distribution of booklets, posters, leaflets and other materials (Revista Exame, 2018)
	A.5.3 - Have standardized and formalized environmental management systems, including comprehensive risk identification, action plan, resource allocation, employee training and auditing.(ISO 14031, 1999)
	A.5.4 - Periodically publish its environmental performance and disclose the consumption of natural resources in administrative processes (ILCD, 2010)

Table A1. Continued...

ECONOMIC PRACTICES	PRACTICE INDICATOR
A.6 - Use of recycled materials in company operations	A.6.1 - Create an approach for evaluating its environmental performance in relation to the practice of recycling materials (Revista Exame, 2018)
	A.6.2 - Evaluate in a structured and systematic way its environmental performance, in relation to recycling, considering the life cycle of its products or services, as a reference for evaluation and monitoring (Schlange, 2006)
A.7 - Use reuse water in your production processes and/or rainwater harvesting	A.7.1 - Seek alternative sources of energy and water for all sectors, in addition to monitoring the efficient use of water and energy consumed (Schlange, 2006)
A.8 - Assessment of your environmental performance	A.8.1 - Periodically evaluates the direct and indirect environmental impacts of its activities, processes, products and services. (ISO 14031, 1999)
	A.8.2 – Identify and assess the risks and opportunities arising from the relationship of its operations and services (ISO 14031, 1999; ILCD, 2010)
A.9 - Research, development and technological innovation for efficient use of resources and cleaner production	A.9.1 - Development of products and services that consider, among others, aspects related to the reduction of the use of resources and the generation of waste (ILCD, 2010; UNEP/SETAC, 2007; Schlegel et al., 2016)
	A.9.2 - Creating shared value through the development of new products that remedy or develop environmental aspects (Porter & Kramer, 2006)
	A.9.3 - Monitor all stages of the production process or execution of services offered, with specific indicators (ISO 14031, 1999)
	A.9.4- Definition of transport and logistics raising the respective environmental aspects for obtaining inputs and distributing the company's products/services (Revista Exame, 2018)
	A.9.5 - Consider the company's responsibility with impacts arising from the by-products and/or post-consumption of its products (UN, 2018)
A.10 - Develop an inventory of emissions from its activities and consider the environmental impacts of its activities	A.10.1 - Minimize the emission of effluents, residues and waste (Schlange, 2006)
	A.10.2 - Ensure legal compliance of the handling, storage, treatment, destination and reverse logistics processes, to raise and monitor their respective environmental inventories - (ISO 14031, 1999; Butt et al., 2015)
A.11 - Mitigation of your own emissions	A.11.1 - Regularize issues of disposal of emissions/liquid effluents from its processes in accordance with applicable legislation (ISO 14031, 1999)
	A.11.2 - Use of more sustainable modes of transport, (Schlange, 2006)
	A.11.3 - Monitor emissions from means of transport, in addition to ensuring and proving that they are in compliance with applicable legislation (emission limits) – (ILCD, 2010; CEBDS, 2018)

Table A2. Research Relevance of Sustainability Indicators

The research aims to develop a Model of Sustainable Performance Indicators for the Construction of Highways. For the construction of this model, the sustainability indicators were divided into 3 dimensions: Economic, Social and Environmental.

The purpose of this questionnaire is to create a ranking of the 3 dimensions and their respective sustainability indicators. The approach adopted is the simplified AHP analysis, in order to classify such indicators in order of relevance, seeking to establish how much the indicator ranked first (the most important) is more relevant than the one ranked second (less important than the first) by the evaluator, and so on.

1 - Classification of dimensions: The Sustainability indicators are divided into 3 dimensions: Economic, Social and Environmental. Please, order the 3 dimensions that appear in the table below by importance, with the most important dimension in 1st and the least important in 3rd.

Dimensions	1º (more important)	2º	3º (less important)
Economics			
Social			
Environment			

2 - Based on the ordering you made in the previous question, compare and answer how much more important the dimension ordered in the first place is than the one ordered in second, marking “A lot” or “Little”, and so on.

	A lot	Little
How much the dimension ordered in 1st is more important than the dimension ordered in 2nd		
How much the dimension ordered in 2nd is more important than the dimension ordered in 3rd		

3 – Now we arrive at the classification of the indicators of the “Economic” dimension. The Economic dimension in this research was divided into 4 indicators. Evaluating the economic dimension, order your indicators by importance, 1st being the most important and 4th the least importante

	1º (more important)	2º	3º	4º (more important)
Sustainable strategic planning				
Project risks and opportunities				
Investment performance management				
Crises and contingency plans				

4 - Based on the ordering you made in the previous question, compare and answer how much more important the indicator ordered in 1st is than the one ordered in 2nd, marking “A lot” or “Little”, and so on.

	A lot	Little
How much the indicator ordered in 1st is more important than the indicator ordered in 2nd.		
How much the indicator ordered in 3nd is more important than the indicator ordered in 3rd.		
How much the indicator ordered in 3rd is more important than the indicator ordered in 4th.		

5 – Next, we arrive at the classification of indicators in the “Social” dimension. The social dimension in this research was divided into 4 indicators. Evaluating the social dimension, order your indicators by importance, with 1st being the most important and 4th being the least important.

	1º (more important)	2º	3º	4º (more important)
Diversity (non-discrimination and eradication)				
Professional Social Development				
Sustainable Management of Suppliers				
Social Investment				

6 – Based on the ordering you did in the previous question, compare and answer how much more important the indicator ordered in the first place is than the one ordered in second, marking “A lot” or “Little”, and so on.

	A lot	Little
How much the indicator ordered in 1st is more important than the indicator ordered in 2nd.		
How much the indicator ordered in 3nd is more important than the indicator ordered in 3rd.		
How much the indicator ordered in 3rd is more important than the indicator ordered in 4th.		

7 – Finally, the classification of indicators in the “Environmental” dimension. The Environmental dimension in this research was divided into 4 indicators. Evaluating the environmental dimension, order your indicators by importance, with 1st being the most important and 4th being the least important.

	1º (more important)	2º	3º	4º (more important)
Environmental liabilities (waste generation)				
Consumption of natural resources				
environmental management				
Atmospheric emissions, liquid effluents and waste				

8 – Based on the ordering you made in the previous question, compare and answer how much more important the indicator ordered in the first place is than the one ordered in second, marking “A lot” or “Little”, and so on.

	A lot	Little
How much the indicator ordered in 1st is more important than the indicator ordered in 2nd.		
How much the indicator ordered in 3nd is more important than the indicator ordered in 3rd.		
How much the indicator ordered in 3rd is more important than the indicator ordered in 4th.		