Sustainability indicators in construction companies

José Fernando de Carvalho Ferreira

Instituto Superior Técnico, Lisboa, Portugal
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Abstract

This dissertation presents the development of a sustainability indicators system suitable for large construction companies. As the main actors in the construction industry, large contractors account for a substantial share of the societal, environmental and economic impacts. A throughout literature review was carried out from which a 72 sustainability indicators model was developed. The model was tested and calibrated by the study of seven large European construction companies' annual reports, including two Portuguese organizations. 61 of the 70 proposed quantitative indicators were successfully calculated leastwise for one company, and 64% of the required values were calculated for the entire sample. The case study showed that the proposed model is currently feasible, while helping to identify potential improvements. A gap was found in the quality and reliability of non-financial information. The use of the proposed SI model is suggested as an effective management tool for construction companies. The standardization of sustainability indicators related methodologies, formulas and processes is also suggested. Companies' sustainability information regulation may be necessary in the near future.

Keywords: Sustainability Indicators, construction companies, economic, environmental and social performance, sustainability report

1. Introduction

The construction industry can have significant impacts in all dimensions of sustainability. At the European Union, the sector provides 18 million direct jobs and contributes to about 9% of the GDP. At the environmental level buildings alone account for the largest share of total EU final energy consumption and produce about 35% of all greenhouse emissions (European Comission, 2016). As key actors in the management of these impacts, construction companies have major responsibilities.

Many developments have already been made in the application of sustainability indicators (SI) in construction. Fernández-Sánchez and Rodríguez-López (2010), Shen *et al.* (2007) and Zhang *et al.* (2014) are among the main contributors to the definition of sustainability metrics at the project level. Apart from those, other authors have explored various paths: Kocmanová and Dočekalová (2012) enhanced a set of indicators using an existing sustainability platform, Zhao *et al.* (2012) developed a model based on sustainability initiatives, while Lu and Cui (2012), starting from the identification of companies' stakeholders, addressed sustainability from the perspective of social responsibility.

These examples do not complete the study of sustainability in construction, as there is still much to be done at the project and company level. Considering the existing literature in the field, very few contributions specifically address large contractors and even fewer were actually applied, or tested, in case studies. In this work a tailor made SI system is developed and proposed. The purpose is to improve companies' performance evaluation processes, particularly within the Portuguese context.

The approach followed included a thorough literature review, and a benchmark identifying the current best practices. These provided the support for a proposal of several KPI's able to monitor and assess sustainability in the context of construction companies. As recommended by Yin (2009) and Searcy *et al.* (2007), after the construction of a theoretical basis and acknowledgement of the existing indicators, a case study was developed. The proposed model was tested in seven large European contractors, using the information released in the official annual account reports and sustainability reports.

2. Theoretical basis

The literature on the subject is abundant in different concepts, frameworks and means of application. As a starting point in the development of a SI model it is useful to clearly define the theoretical boundaries of the concepts.

With regard to sustainability, there is not a universal definition accepted. However, it is possible to summarize the implicit elements common to most definitions (Vos, 2007). Thus, sustainability is an integrative and multidisciplinary field in which the causes, effects and interactions of human action in society, environment and economy are studied simultaneously. All these aspects are analyzed considering a time frame of several decades, in order to guarantee a fair distribution of resources among generations. These sustainability efforts presume that actions taken go beyond what is stated in current laws and regulations (Moldan *et al.*, 2012; Székely and Knirsch, 2005; Vos, 2007).

Likewise, when applying the sustainability definition within a business context, it is necessary to choose between a strong and a weak approach, even though they are not necessarily opposing concepts (Kuhlman and Farrington, 2010). While the former does not admit losses in a dimension at the expense of another, the latter allows an interchangeability (trade-off) between the valuations assigned (Wu and Wu, 2012). The notion of sustainable corporation proposed by Dyllick and Hockerts (2002) is adapted as a starting point, in which a corporation is required to be simultaneously:

- Economically sustainable: guarantees a cash-flow sufficient to provide liquidity at any point, while producing returns for its shareholders. Adds economic value with its activity;
- Socially sustainable: adds value to the communities by increasing the human capital of individual partners and manages social capital in a way that stakeholders understand its motivations;
- Ecologically sustainable: does not participate in intrinsically destructive activities and manages its inputs or outputs of natural capital respecting a recovery rate for the environment.

All these notions admit that the types of capital mentioned are non-substitutable, and that there is a point of irreversibility and non-linearity to social and natural capital.

3. Overview of the construction industry from a sustainability perspective

3.1. General aspects

Compared with other industries, construction is characterized by a range of singularities that add complexity to the analysis. The creation and development of constructions, companies' operational activities, occur prevailingly at the project level. These projects are generally unique, dynamic and are exposed to unforeseeable external factors, from which result singular products (Cremers, 2009; Toor and Ogunlana, 2008). Conversely, the construction industry method of operation is fragmented, with multiple procurement systems and specialties, carried out by several stakeholders with different interests (Cremers, 2009; Toor and Ogunlana, 2008).

3.2. Economic aspects

The construction industry is considered a barometer of Portuguese economic activity (INCI, 2013) and a proven tool for promoting growth (Wibowo, 2009). Its economic impacts, resulting from the chain of investment and reinvestment, can be summarized as direct, indirect or induced. These contributions are the consequence of both managerial options and the economic context. In the last few years, the Portuguese industry has accumulated losses in all its subsectors. After the 2008 economic crisis Portuguese companies suffered abrupt losses in their turnover and profits (Banco de Portugal, 2014). However, even though the economic crisis emphasized losses (Comissão Europeia, 2011), it is argued that the contraction in the Portuguese sector started more than a decade ago (da Costa, 2009), as the trends show in two critical macroeconomic sectorial indicators, Gross Fixed Capital Formation (GFCF) and Gross Value Added (GVA), suggest. Considering all economic activities, construction's GFCF dropped from 4.85% to 2.65% between 2001 and 2013 and from 7.74% to 4.51% in the same period for GVA.

Two sets of constrains that help providing a sound explanation for these macroeconomic trends were identified: structural and exogenous. Using Porter's five forces based model, Vaz *et al.* (2014), identified long term structural constraints that reduce Portuguese companies' competitive performance, such as: the high cost of energy, a weak innovative performance, a high tax burden, lack of support from the public sector and the relatively small size of Portuguese companies. According to the companies' view, the exogenous constrains derive from capital unavailability and lack of internal demand (INE, 2015).

Nonetheless, the largest Portuguese companies achieved a considerable profit growth in 2012 (Espírito Santo Research, 2013), which is explained by the diversification and internationalization of their activity. This strategy is identified in the literature as a way of maintaining the turnover volume, but incorporates risks, justified by the need of greater technical and organizational capability, which cannot be underestimated (Han *et al.*, 2010).

3.3. Social aspects

In order to establish the scope of social responsibilities attributable to organizations, stakeholder mapping was performed. Although this procedure should be individualized, it is possible to identify a set of stakeholders relatable to all construction companies (Chereja *et al.*, 2013). This work has been done by Zhao *et al.* (2012), who selected employees, shareholders, customers, suppliers and partners, government, competitors, Non-Governmental Agencies and local communities as the main stakeholders.

With regard to customers, it has been identified that Portuguese companies frequently disregard contractual agreements such as deadline meetings and budgeted figures (Pires *et al.*, 2007; Ribeiro *et al.*, 2013). Fulfilling customer requirements, such as quality and durability of products and components, is a crucial aspect in ensuring sustainability. In fact, all trades should be guided by scrupulous compliance with all contracted elements. Moreover, it is expected that companies take responsibility for their commercial options in regards to goods and services (Zhao *et al.*, 2012). When considering competitors as stakeholders, concerns have been identified regarding unethical market practices, namely abnormally low prices and tax evasion (Comissão Europeia, 2011).

Since employees are the most directly affected stakeholders, earnings, health and safety (HS) conditions, workplace equity and skills development must be regarded. These issues are not only important in the short-term, but are essential in the long-term, in order to avoid skilled labour shortage. In the Portuguese territory, the following issues have been identified:

- high unemployment (IEFP, 2015);
- low skills and lack of education ("EU Skills Panorama - European Commission - Home," n.d.);
- horizontal and vertical inequality with women and migrants (Byrne *et al.*, 2005);

- poor HS performance.

3.4. Environmental aspects

Knowing that in most cases environmental aspects and impacts are analyzed at the project level, it is possible to establish a set of general environmental impacts occurring in most constructions and that are aggregable at the company level (Matar *et al.*, 2008). In this study, the conceptualization proposed by Pinheiro (2006) is used as a means of summarizing the main environmental aspects and impacts.

During the construction process, land, materials, energy and water are the main primary resources required. According to environmental sustainability criteria, the destruction of natural resources, without its subsequent replenishment, burdens natural capital. The environmental impact of the construction process is significant, water may be contaminated and acidified, the richest upper layers of the soil may be destroyed and soil type definitively changed. Furthermore, the consumption of construction materials may lead to the destruction of raw material stocks, while most of the energy consumed comes from non-renewable sources (Pinheiro, 2006; Unep, 2003).

Adding to these inputs, emissions and environmental loads are the undesirable outputs occurring in the process (Pinheiro, 2006). If not properly addressed these externalities may impact the natural and built environment: the effluents pollute water and soils, greenhouse gases release into the atmosphere contributing to global warming, noise and vibration deteriorates air quality, while solid waste not only takes up space in landfills, but also leads to the further consumption of resources during transportation. Consequently, deriving from input acquisition, final structures and construction processes, natural and built-based environmental systems changes occur (Pinheiro, 2006).

3.5. Sustainable processes and practices

The realities presented summarize some of the key aspects to be sustained. However, these elements are not sufficient in the evaluation of a company's performance in regard to sustainability, not the least because causes and effects of managerial actions take time to become evident (Comissão Europeia, 2011). There are multiple initiatives and tools that provide guidance on the integrated evaluation of sustainability issues, which can be applied at the company level. Tan *et. al* (2011) grant a systematization of practices associated with more sustainable companies, as shown in Table 1.

Table 1 - Sustainable practices and principles in construction companies (Source: Tan *et al.*, 2011)

Sustainable practices	Principle
Internal processes and organizational structure	Organizing the organizational processes and structure, allowing sustainability within the operational level
Compliance and sustainability initiatives	Complying with environmental and social regulations, promoting proactivity
Measurement and report	Developing and/or improving the report and measurement systems
Design and procurement	Built product improvement from the design stage, promoting best practices in contracting and procurement throughout the supply chain
Education and training	Increasing technical knowledge necessary to sustainability in practice
Technology and innovation	Promoting the innovative strategically components and the technological ability

The introduction of sustainability in a company's internal processes and organizational structure aims at its integration in daily operational activities (Buchholz and Rosenthal, 2005). During this process, a clear definition of responsibilities is needed, especially at the top management level (Eccles *et al.*, 2012). The incorporation of Management Systems is among those practices that help improve processes sustainability (Griffith and Bhutto, 2008).

Compliance and participation in sustainability initiatives are beneficial to the business' image and its relationship with stakeholders, while also enabling the anticipation of possible future legal obligations (Nidumolu *et al.*, 2009). These processes, whether for external or internal demonstration, imply some way of measurement and reporting system. The quality of the reporting system assists the statement of organizational sustainable performance to external stakeholders, while providing managers with elements for sound decision-making.

On an activity specific level, it is during the design phase that most important decisions regarding the performance of built products are made, also at a lower cost (Ferreira *et al.*, 2014). Traditional contracting models, in which the tendering phase succeeds the design development, do not allow contractors to apply all their knowledge in sustainability (Kibert, 2013). To assist in assessing the sustainability of the final product, a combined approach is recommended, using available tools that enable the analysis for different types of constructions, such as LEED and BREAM (Ferreira *et al.*, 2014), and simultaneously incorporating the contractor since the project stage (Kibert, 2013). This approach leads to more sustainable designs with less conflicts between different specialties, giving the contractor increased responsibilities in relation to the final product performance.

Purchases of materials and services take on a significant portion of all construction costs. The incorporation of a sustainable procurement practices throughout the supply chain help improve the overall organizational performance. For both services and products purchased, using the lowest price as the sole decision criterion should be avoided. Materials and raw goods purchased this way may entail major environmental consequences, while subcontracting as a way to lower prices may have negative consequences for workers (Ng and Tang, 2010).

Education and training, technology and innovation are among the most important sustainable-related processes at the company level. If construction companies have the merit of hiring workers with little education, it is their responsibility to train them. Along with technology and innovation, education and training is one of the main ways for a company to improve its HS conditions and productivity (Haslam *et al.*, 2005). At the same time, the continuous development of skills is often needed in order for workers to implement the most innovative constructive solutions, which are often the most sustainable.

4. Proposal of a sustainability indicators model

4.1. Conceptual framework

In order to arrange the indicators model, Sikdar's (2003) framework was adopted. Consisting of seven dimensions and three hierarchical levels, this framework is compatible with and allows overcoming some of the known limitations of the Triple Bottom Line (TBL), the most widely adopted framework. In Sikdar's framework (2003), the first hierarchical level, one-dimensional, is identical to the TBL, comprising the social, economic and environmental dimensions. In the second hierarchical level, two-dimensional, one-dimensional levels are combined. Lastly, the tridimensional level comprises the aspects that promote economic, social and environmental development simultaneously.

In terms of logical organization, the model is constituted by seven dimensions, in which one or more themes are contained. The themes portray the key issues identified in the literature relevant to companies' sustainability. Each of these themes is monitored by one or more SI.

4.2. Economic indicators

The economic dimension is constituted by three themes: economic returns to stakeholders, financial condition and strategy and risk exposure. The themes and indicators are shown in Table 2.

The economic returns to stakeholders result directly from the definition of an economically sustainable company. Like in direct economic impacts at industrial level, this theme is estimated by the GVA, which can be calculated in a standardized way, using the International Accounting Standards.

Given the plethora of existing indicators and financial ratios, a total of 13 indicators have been adapted from Öcal et al. (2007), who studied financial ratings suited to large construction companies. The financial ratios used are profitability, liquidity, leverage and activity ratios.

According to the main strategies used by companies in response to exogenous and structural constraints, two reference type indicators were introduced in the last theme. As sources of immediate risk, it is useful to monitor the strategies that ultimately influence the economic indicators.

Table 2 - Economic indicators

Economic returns to stakeholders		**Financial condition: leverage**	
E1	Gross Value Added	**E9**	Net financial costs
Financial condition: profitability		**E10**	Current assets percentage
E2	Return on equity	**E11**	Receivables by total assets
E3	Return on assets	**Financial condition: activity**	
E4	Return on sales	**E12**	Working capital turnover rate
E5	EBITDA margin	**E13**	Assets turnover rate
Financial condition: liquidity		**E14**	Long term assets turnover rate
E6	Current ratio	**Strategy and risk exposure**	
E7	Quick ratio	**E15**	International turnover
E8	Financial autonomy	**E16**	Turnover by sector of activity

4.3. Social indicators

Following the theoretical research, a set of 24 social indicators is proposed, divided by 7 themes, as presented in Table 3. The employment and hiring practices cover aspects such as labour force fluctuation over time, turnover rates, employees' type (white collar or blue collar) and contract type, such as part-time and temporary. The HR policies are understood in terms of the employability and long-term skills development, focus being given to the investment in HR, embodied by wages per employee, frequency and spending on training and education.

Two further themes consider employees, namely equity at the workplace and occupational HS conditions. In the equity at workplace assessment, horizontal and vertical minority groups proportions are calculated, in other words, among all employees or constricted to management positions. In this theme, compliance with human and labour rights is determined. The HS indicators should be applied both to company's employees and all subcontractors. Three traditional HS indicators are used, number of serious accidents, LTIIR and LTIFR. To each a leading indicator is added based on HS certification. Contrary to traditional passive indicators, leading indicators provide valuable information before the occurrence of negative consequences (Hinze *et al.*, 2013).

For customers and end users, the ratio between the actual and the expected construction guarantee is calculated in order to evaluate product quality, safety and suitability. The same reasoning, in monetary value, is applied to defects corrected during warranty and the total construction value.

Respect for partners, competitors, suppliers, and other stakeholders is understood by contractual compliance and monitored by the reason between the theoretical value and the actual value in terms of budgeted and contracted deadlines. The instances where legal action was taken against a company that was then found guilty are also monitored in number and total amount (S22). In order to determine the level of support that the company gives to the local community, their budget allocation for social investment is assessed. This metric is complemented by a descriptive indicator where the activities in which the local communities investment is spend are emphasized.

Table 3 - Social indicators

Labor force profile		**Health and safety**	
S1	Number of employees and annual change	**S14**	Lost time injury incidence rate (LTIIR)
S2	Employees' age (<30 ; [30-50] ; >50)	**S15**	Lost time injury frequency rate (LTIFR)
S3	Part-time and temporary employees percentage	**S16**	Number of serious accidents
S4	Blue-collar workers percentage	**S17**	Health and Safety certification
S5	Turnover rate	**Product quality, safety and suitability**	
Human resources investment		**S18**	Theoretical to actual guarantee release ratio
S6	Personnel costs per employee	**S19**	Construction defects to total value ratio
S7	Salary per employee	**Ethics and contractual compliance**	
S8	Education and training per employee	**S20**	Theoretical to real budget ratio
S9	Training costs per employee	**S21**	Theoretical to real construction time ratio
Equity at the workplace		**S22**	Number and amount payed (legal actions lost)
S10	Highest to average salary ratio	**Local communities**	
S11	Total Human rights and workplace complaints	**S23**	Main social activities (descriptive indicator)
S12	Women and migrants proportion in general	**S24**	Social investment per net result
S13	Women and migrants proportion in management		

4.4. Environmental indicators

Two types of environmental impacts can be distinguished with implications on the way they are monitored: generalized impacts and singular and/or noncumulative. The former occur in most constructions while the latter are exclusive to singular contexts and are not cumulative.

Both themes, pressure on natural resources and emissions and effluents, result directly from the environmental impacts conceptualized by Pinheiro (2006). The gross generalized impacts mentioned in the literature review are covered by each of the A1 to A7 indicators, as shown in Table 4.

Environmental impacts and aspects, do not necessarily result in negative consequences, because there are ways to mitigate and/or control them. Consumption of materials can be reduced by recycled and reused materials, renewable energy is becoming a viable alternative to fossil fuels, while a great percentage of waste can be recovered. These issues are monitored by the theme "positive pressures".

Table 4 - Environmental indicators

Pressure on natural resources		**Positive pressures**	
A1	Materials consumption	**A8**	Percentage of recycled and reused materials
A2	Energy consumption	**A9**	Percentage of renewable energy
A3	Water consumption	**A10**	Percentage of waste recovered
A4	Pressure on the land	**Environmental Management (EM)**	
Emissions and effluents		**A11**	Percentage of operation under an EMS
A5	CO_2 emissions		
A6	Waste production		
A7	Effluents production		

Environmental management (A11), indicates how companies are prepared to deal with the singular and non-cumulative impacts and with the environmental systems of natural basis changes.

4.5. Economic and environmental indicators

The environmental and economic indicators chosen are based on the concept of eco-efficiency. As relative indicators, it is intended to compare performance between different companies. These indicators result from the division between an environmental indicator and an economic measure. Depending on the unidimensional environmental indicators, two subthemes were generated: inputs and outputs. Three input indicators were chosen from the corresponding pressure on natural resources theme. Likewise, two output indicators from the corresponding emissions and effluents indicators were identified, as presented in Table 5.

Table 5 - Economic and environmental indicators

Ecoefficiency: inputs		**Ecoefficiency: outputs**	
EA1	Materials efficiency	**EA4**	CO_2 efficiency
EA2	Energy efficiency	**EA5**	Waste production efficiency
EA3	Water efficiency		

4.6. Social and environmental indicators

Traditionally, construction procurement processes are based on the principle of the best price in the shortest amount of time with the highest quality. Considering these parameters already ensured, the same cannot be outlined for the environmental and social aspects. Knowing that purchases account for a large portion of all organizational expenses, it is important to monitor the environmental and social aspects of these practices, which is the main purpose of the social and environmental indicators.

The first metric proposed indicates which type of purchase (materials and goods or services) is most widely employed by the company, helping the prioritization of subsequent indicators. The SA3 indicator is based on the suggestion that the longer the subcontracting chain, the less specialization there is (Cremers, 2009). The SA4 indicator is qualitative and descriptive, by which it is intended that companies describe the general procedure that guides their procurement practices.

The rest of the indicators can be classified as proxy indicators, which are useful to assess a reality that is not directly measurable (Wilkinson and Kirkup, 2009). Proxy indicators are used to measure the sustainability of materials and services purchased, estimated by certification usage.

Table 6 - Social and environmental indicators

Procurement and supply chain		**SA4**	Procurement procedures (descriptive)
SA1	Services and products expenses	**SA5**	Supplier's environmental certification
SA2	Sustainable products acquisition	**SA6**	Supplier's health and safety certification
SA3	Supply chain verticality		

4.7. Social and economic indicators

Social and economic indicators comprise three realities among the social and the economic dimension, namely productivity, relative personnel costs and geography, as shown in Table 7.

The organizational means of production effectiveness are measured by productivity, defined as the economic value generated by employee. Being an important indicator, it is dependent on workers efficiency. In order to evaluate the relative investment in HR, regardless of the economic value generated, the operational expenses by personnel costs calculation is proposed.

It is known that the economic output depends on the economy of the location, given that prices of goods and services differ with the local economic conditions. In order to evaluate the extent of this effect, the indicator SE2 is suggested, by which a homogenized preferential market value type for each company is estimated. This indicator is given by the formula:

- $\boldsymbol{CL = \sum \frac{VN_i}{VN} xPPP_i}$ with PPP = purchasing power parity (by country) and VN = Turnover

Table 7 - Social and economic indicators

Productivity		**Pondered spend by employee**	
SE1	Value gross added per employee	**SE3**	Operational expenses by personnel costs
Geography			
SE2	Location coefficient		

4.8. Tri-dimensional indicators

In order to categorize the tri-dimensional aspects, four themes were selected, contractual autonomy, final product sustainability, research and development and compliance, as shown in Table 8.

The goal for the first theme is the assessment of the proportion of contracts in which the constructor has responsibilities in the design. This data is vital to assess the degree of responsibility that the contractor has on its products performance. In the final product sustainability theme, well tested tools and sustainability rankings are used. All these tools are applicable to most construction and characteristically used as a way to sort the standard rank of an organization products. Two indicators are used for this purpose, the average rank and the extent of its use in the company.

The technological and technical developments are traditionally monitored by the number of patents, the amount invested, degree of collaboration with other entities and number of products and innovative solutions introduced (Flor and Oltra, 2004). Knowing that innovation occurs within the organization in two ways, namely through the operational experience gained, and through strategic research activities (Miozzo and Dewick, 2002), indicators are proposed that reflect organizational potential concerning these aspects.

Compliance was identified as associated with high sustainability companies. The compliance performance is evaluated by the assessment of organizational gross amount and number of (social, environmental or economical) fines payed during a time frame.

Table 8 - Tri-dimensional indicators

Contractual autonomy		**Innovation and research**	
T1	Design or post design intervention stage	**T4**	Partnership in R&D
Final product sustainability		**T5**	Patents
T2	Average sustainability ranking	**T6**	R&D investment
T3	Sustainability ranking ratio	**Compliance**	
		T7	Compliance: number and value

5. Case study

The case study was intended to test the system, anticipate practical difficulties, review best reporting practices and find alternate indicators and globally test the applicability of the model. Two of the largest Portuguese companies who disclose sustainability reports were chosen. It was found that these companies have a diversified activity, a large share of international turnover and are not too specialized. Five similar European companies were chosen completing a set of seven companies. Using their official reports as information source, the model was applied to each company for three consecutive years, 2012 to 2014. A summarized version of the results is presented in Table 9, namely the global percentage of calculable indicators, the percentage of indicators determined in at least one company and the number of SI determined in at least one organization.

Table 9 shows that 61 of the 70 quantitative indicators are currently calculable, meaning that the model is feasible at the present moment. From the nine non calculable indicators one is environmental, three are social, and three socio-economic and two are tridimensional. Regarding non-financial indicators, the less traditional the indicator, the less common its use. The socioenvironmental indicators, which monitor the procurement and supply chain practices were significantly less calculable, which is detrimental, if ones considers that 57% to 82% of these companies' operational expenses were either from materials or services purchase.

Data availability justifies the differences in the applicability between financial and non-financial indicators. Three types of constraints were found in the sustainability information disclosed:

- Lack of consolidation - the data presented was not always relative to the whole company;
- Omission/non monitoring - some of non-financial data is not disclosed, even when a topic is mentioned as relevant to that company's sustainability;
- Inconsistency - indicators with the same designation but different methodologies are common.

Table 9 - Case study results

Dimension	% Calculated (%)	% Calculated Min 1	Nº SI Min 1
Economic	97	97	16/16
Environmental	52	57	10/11
Social	62	71	20/23
Socioeconomic	81	81	3/3
Ecoenvironmental	80	80	5/5
Socioenvironmental	23	57	2/5
Tridimensional	24	34	5/7
Total	64	74	61/70

As a consequence of the lack of regulation, the companies choose not to disclose potentially negative information. Two alternative indicators are suggested as a way to increase the model applicability, using financial statement provisions in exchange for indicators S19 and S22, which were not calculable for any company. The alternative indicators proposed are:

a'S19	Construction warranty provisions by turnover	**a'S22**	Legal provisions by turnover

6. Discussion

The purpose of this work is the development of a SI model, addressed to the largest Portuguese companies. It was found that the model developed is applicable today, because most of the indicators were calculable for at least one company. A gap between the availability and quality of financial and non-financial data was found. This gap has repercussions on the indicators and ultimately on the conclusions taken from them. Differences in methods, lack of consolidation, omissions and inconsistency were the main constraints found. Despite this fact, there is relative extent of agreement between companies in some aspects to be sustained. Most of the constraints can be explained by the lack of regulation surrounding one or another data type. It urges the consideration of SI and sustainability reports as valuable scientific tools, and less as marketing instruments.

Despite the value attributable to this model, more practical application is needed. A mid-term research partnership with a construction company could greatly improve the enhancement of methods and formulas, from the data acquisition stage to the actual model application.

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