Algorithm applied in corporate sustainability

Abstract

Purpose – Scientific studies indicate that stakeholder's engagement is a key factor for the creation of sustainable value in companies. The manuscript aims to evaluate the sustainability of a sports company and propose a tool to prioritize the relevant issues that this company should consider in its operations.

Design/methodology/approach – Stakeholder Theory and Global Reporting Initiative (GRI) are considered and, from the Fuzzy Logic, it proposes a decision-making tool to establish the relevant issues. The "Experton Method" is used in this paper.

Findings – The algorithm used can help decision makers in processes that include the stakeholder's opinions. In this case, a tool that treats qualitative data in a reliable manner is required. The methodology used allowed knowing the stakeholders expectations and to define priorities in sustainability issues. The results were captured in a materiality matrix. The manuscript concludes that including stakeholders in the decision-making process, the company generates trust and legitimacy of its stakeholders. This participatory approach and the use of algorithm help companies in materiality assessment, definition of priority issues, and management of resources.

Practical implications - In terms of managerial implications, this paper presents a useful tool that can help entrepreneurs in the decision making to manage their suppliers. Using an algorithm of fuzzy logic applied in the supply chain management we indicate how to set priorities to build a consistent CSR plan in order to achieve corporation success. This methodology allows reducing subjectivity; it generates greater precision and decreases the risk in decision-making. At the same time, it promotes dialogue and collaboration among stakeholders to create value for stakeholders and CSR, and collaborate to have a responsible company performance. Furthermore, this paper provides theoretical applications in terms of the literature review on corporate sustainability, indicating that companies must consider the stakeholder´s engagement in its strategies. Based on the bibliometric study, there are knowledge gaps on the subject. For these reasons, an important contribution is observed at the academic level that allows expanding the frontier of knowledge on the subject.

Originality/value – A tool for decision making is presented with great utility for entrepreneurs in the processes of dialogue and stakeholder's engagement, being a contribution for the creation of sustainable value. In addition, there is an important scientific contribution because the paper identifies in the literature the knowledge gaps on the subject.

Keywords: Innovation, Corporate Sustainability, CSR, Stakeholder Engagement, Fuzzy Subsets.

Paper type: Research paper

1.**Introduction**

The companies that look for a sustainable development in its businesses must consider the stakeholder's engagement in its strategies. The "Stakeholder Theory" (Freeman, R.E., 1984) has evolved in recent decades and several authors have indicated that the commitment with stakeholders is a fundamental element for value creation over time (Barcellos de Paula and Marins, 2018; Bonsón Ponte et al., 2015; Carroll, A.B. and Buchholtz, A.K., 1989; Donaldson, T. and Preston, L.E., 1995; Freeman et al., 2010; Gil-Lafuente and Barcellos Paula, 2013; Hart, S.L. and Sharma, S., 2004; Hill, C.W.L. and Jones, T.M., 1992; Mitchell, R.K. et al., 1997; Paula, L.B., 2011; Post, J.E. et al., 2002; Spitzeck and Hansen, 2010; Wagner Mainardes et al., 2012). However, stakeholder management was never an easy task for companies. It becomes increasingly complex due to the expansion of international markets, and the constant technological, economic and social changes. It can be considered that the relations with stakeholders are affected by these transformations, which demand from employers more knowledge and skills to dialogue with a broader range of stakeholders, and deal with emerging topics and responsibilities, such as climate change, ethics, human rights, supply chain, child labor, transparency, among others. For these reasons, both at an academic and business level, companies shall assess the development of tools that facilitate decision-making, reduce risk, and at the same time promote dialogue and collaboration among stakeholders.

According to the authors (Freeman et al., 2010), the corporate social responsibility (CSR) should be integrated throughout the organization, in a cross-cutting manner involving the participation of all areas of the organization. By definition, the company must seek the addition of social, ethical, environmental, economic, and criteria and the moral position of all stakeholders. According to the same authors, the responsible company seeks to create value for its stakeholders and CSR is proposed to contribute to the overall success of the corporation. To achieve this challenge, Freeman et al. (2010) suggested a business model for companies with the creation of partnerships with stakeholders and include stakeholders' participation in its CSR processes. For Porter and Kramer (2002) enterprises cannot solve all the problems of society, for a matter of cost, resources and time. On the other hand, companies must prioritize the issues that affect its business, optimizing resources and expectations. This is a challenge for companies that need to rank relevant or material issues in its corporate social responsibility plans.

To face these challenges and help companies to improve their CSR management plans, an algorithm to prioritize relevant topics or materials is

proposed. Although we had seen before fuzzy logic applied to support sustainable development in business and scientific fields, we have chosen to use the "Experton Method" in this paper as a result of its specifics benefits. According to Gil Lafuente, A.M. and Gil Lafuente, J. (2007), this methodology has advantages over other tools that deal with uncertainty, since it allows specialists opinions to be added simultaneously with the flexibility provided by fuzzy numbers. It is also a user-friendly tool. In this way, it is intended to reduce subjectivity, achieve greater precision in the results, and reduce the associated risks in decision-making. According to Merigó et al. (2010) this methodology allows assessing the group decision making problems in a more complete way. For this reasons, the "Experton Method"(Kaufmann and Gil Aluja, 1993) was applied in the evaluation and materiality analysis of a multinational sports equipment company. This algorithm constitutes an important advance of the fuzzy subsets developed by Kaufmann (1987). It is important to mention that this methodology applied to sustainability comes from a previous study (Paula, L.B., 2011).

Furthermore, it can be seen that several authors used this methodology in different topics such as dialogue with stakeholders (Barcellos Paula, Luciano and Gil Lafuente, Anna María, 2010; Gil-Lafuente A. and Barcellos Paula L, 2010), evaluation of quality management system (Brotons and Sansalvador, 2017), codes of ethics for franchises (Gámez-González et al., 2010), decision making (Merigó, J. et al., 2010; Sirbiladze and Gachechiladze, 2005), corporate social responsibility (Yepes-Baldó et al., 2016), and establishment of the project credit risk level (Sirbiladze et al., 2014). In this context, this paper aims to broaden the discussion on sustainability in companies and propose solutions for decision-making based on fuzzy logic. To clarify the subject, this paper submits a proposal for the sustainable development of the companies using an algorithm in the prioritization of relevant topics or materials. The results demonstrate the usefulness of this tool for companies in the decision making process, and the effectiveness to seek sustainable operations. On the other hand, future research studies on this subject are promoted.

To achieve the proposed objectives, the applied quantitative research method was applied in the modelling and simulation, as showed in Figure 1.

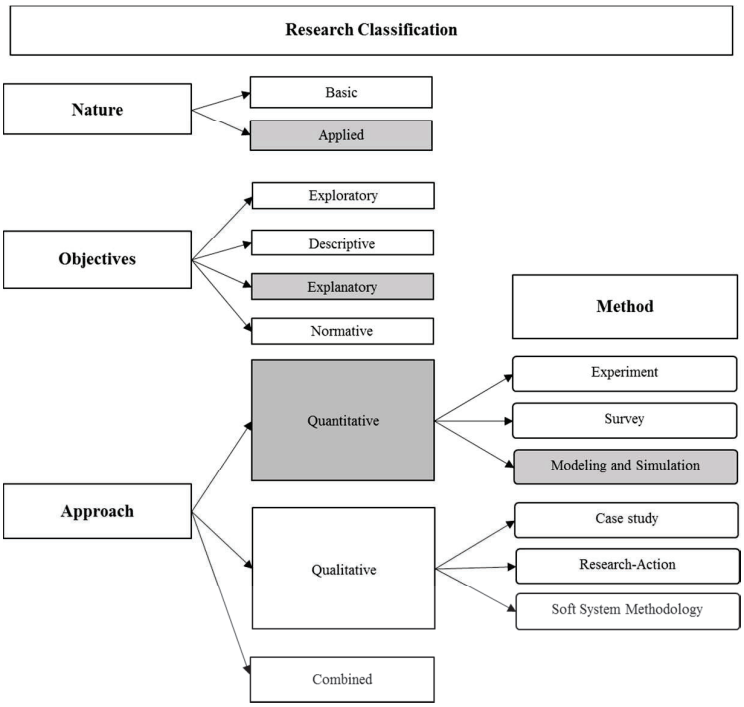

Figure 1. Research classification.
Source: Own source based on Turrioni and Mello (2012).

This manuscript is structured as follows:

- Section 2 introduces the bibliometric study.
- Section 3 describes the methodology the "Experton Method".
- Section 4 proposes a fuzzy logic application to prioritize relevant issues of the stakeholders of a sports company. In this case, the Experton algorithm is used to achieve the proposed objectives. The results confirm the validity and utility for companies in the decision-making processes.
- Section 5 presents the future lines of research.
- Section 6 shows the conclusions of the manuscript, followed by the bibliographical references.

2. Bibliometric Study

This section includes a bibliometric study on fuzzy logic in sustainability. The objective is to show the evolution of publications and citations on the

subject in the last twenty years, and to identify the most cited works and authors. With this information, it is also intended to detect the research gaps and future lines of research on the subject. It is worth noting that we performed a brief bibliometric study using the keywords “fuzzy logic” and “sustainabilit*”. The study was conducted on January 31, 2018 and the information obtained may vary over time since, as these are publications, their number constantly increases over time and the topics are expanded while producing interdisciplinary connections. The results indicate that the combination between fuzzy logic and sustainability has been little investigated so far. Figure 2 shows the results of publications (213 papers) and citations (2,684) obtained through the Web of Science.

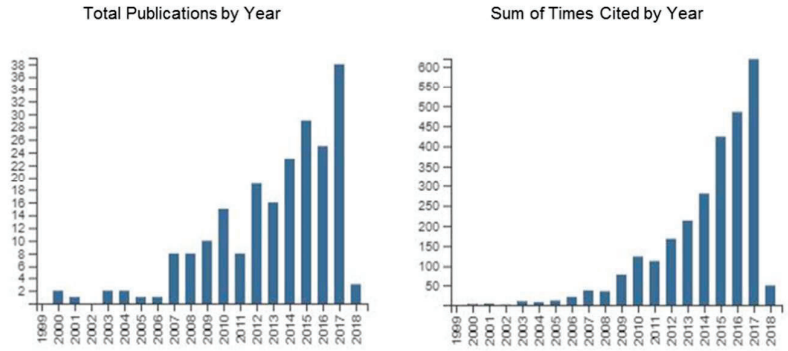

Figure 2. Bibliometric study.
Source: Web of Science (2018)

It is emphasized that the conducted research may include small deviations, since not all the papers that match the combination of words “fuzzy logic” and “sustainabilit*” will be useful in our research. The results presented a growing trend in the number of publications. The increase in citations in the last twenty years reinforces the interest in the subject. It was evidenced that there is an opportunity to be explored with an innovative research in this area. Tables I and II present the seven most cited papers using the keywords “fuzzy logic” and “sustainabilit*” according to Citation Report. Table I presents the contributions of each paper and Table II shows research gaps and future research.

Table I. The most cited works using the keywords "fuzzy logic" and "sustainabilit*". Source: Web of Science (2018).

N°	Authors	Papers	Contributions
1	(Phillis and Andriantiatsaholiniaina, 2001)	"Sustainability: an ill-defined concept and its assessment using fuzzy logic"	"The Sustainability Assessment by Fuzzy Evaluation (SAFE) model is developed, which provides a mechanism to measure the sustainability of development. The result of the model is a degree (%) of sustainability of the system under examination (location, state, country)".
2	(Lu et al., 2007)	"Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis"	"A tool is presented to help the supply chain manager measure and evaluate supplier performance based on an analytical hierarchy process (AHP) decision making method".
3	(Büyüközkan and Çifçi, 2011)	"A novel fuzzy multi-criteria decision framework for sustainable supplier selection with incomplete information"	The authors "examine the problem of identifying an effective model based on the principles of sustainability for supplier selection operations in supply chains".
4	(Amindoust et al., 2012)	"Sustainable supplier selection: A ranking model based on fuzzy inference system"	The authors "suggest the application of "Fuzzy Inference System" (FIS) to evaluate suppliers and it propose a new classification method on theme".
5	(Bockstaller et al., 2008)	"Agri-environmental indicators to assess cropping and farming systems. A review"	"The paper discuss the application of agro-environmental indicators used to evaluate the adverse effects of agricultural and agricultural systems on the environment, such as water pollution, soil erosion and the emission of greenhouse gases".
6	(Andriantiatsaholiniaina et al., 2004)	"Evaluating strategies for sustainable development: fuzzy logic reasoning and sensitivity analysis"	"An analysis of the SAFE model is carried out to identify the most important factors that contribute to sustainable development. The proposed method is applied to the Greek and American economy with 80 different indicators".
7	(Lazaroiu and Roscia, 2012)	"Definition methodology for the smart cities model"	"A model is proposed to calculate the smart city indices. The document deals with the calculation of the assigned weights for the considered indicators. The proposed approach uses a procedure based on fuzzy logic and defines a model that allows us to estimate the smart city".

Table II. Gaps and suggestions for future research from the most cited works using the keywords "fuzzy logic" and "sustainabilit*". Source: Web of Science (2018).

N°	Authors	Papers	Gaps / suggestions for future research	Times Cited
1	(Phillis and Andriantiatsaholiniaina, 2001)	"Sustainability: an ill-defined concept and its assessment using fuzzy logic"	"The SAFE model can become a useful aid for the political and decision-makers in their struggle for increasingly sustainable policies".	161
2	(Lu et al., 2007)	"Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis"	"To develop tools that help suppliers to improve the environmental performance of their products or manufacturing processes of suppliers, customers or both".	148
3	(Büyüközkan and Çifçi, 2011)	"A novel fuzzy multi-criteria decision framework for sustainable supplier selection with incomplete information"	"The proposed supplier evaluation model can be applied in future applied research".	125
4	(Amindoust et al., 2012)	"Sustainable supplier selection: A ranking model based on fuzzy inference system"	"An illustrative example is used to show the feasibility of the proposed method, but it can be applied in future applied research".	107
5	(Bockstaller et al., 2008)	"Agri-environmental indicators to assess cropping and farming systems. A review"	"When more detailed information is available, indicators based on operational models can be useful to analyze the effects of various factors related to soil, climate and the cropping system on an environmental impact".	90
6	(Andriantiatsaholiniaina et al., 2004)	"Evaluating strategies for sustainable development: fuzzy logic reasoning and sensitivity analysis"	"The conclusion is that there is no single sustainable path and, therefore, policy makers must choose different criteria and strategies to make efficient and sustainable decisions for each country".	84
7	(Lazaroiu and Roscia, 2012)	"Definition methodology for the smart cities model"	"The model could help in the policy formulation process as a starting point for discussion among stakeholders and be applied in future scientific research".	80

The results of the bibliometric study indicate gaps and future lines of research with the use of fuzzy logic algorithms in sustainability, decision making related to identification, prioritization and dialogue of stakeholders, grouping opinions, definition of relevant topics or materiality, strategic management with stakeholders, choice and definition of sustainability projects, among others. However, there are important recent research studies that use fuzzy logic applied to sustainability. These showed that the topic is relevant and offered many possibilities for research in different areas, such as transport, bank, agriculture, industry, among others. The main recent papers are mentioned below.

The authors (Barcellos de Paula and Marins, 2018) considered the stakeholders' opinions and used fuzzy logic algorithms to facilitate the decision-making on sustainable transport. According to Dočekalová et al. (2017), there are inconsistencies of composite sustainability indicators, and fuzzy logic can contribute positively to the performance of corporate sustainability. On the other hand, for Bottani et al. (2017), "Fuzzy Logic" can be a very valuable tool to measure sustainability considering the environmental, social and economic dimensions against the key performance indicators (KPIs). The authors (Beheshtinia and Omidi, 2017, p.1386) "propose a hybrid multiple criteria decision-making (MCDM) technique for performance evaluation of banks in which the banks are assessed and ranked according to the criteria of the balanced scorecard (BSC) methodology and corporate social responsibility (CSR) views". For Mitropoulos and Prevedouros (2016), fuzzy logic is a more stable and flexible method because it can incorporate quantitative and qualitative judgment criteria. The same authors make an important contribution by applying fuzzy logic to assess sustainability in transport planning and decision making to choose the best mode of transport. Another interesting application of the fuzzy logic (Lamastra et al., 2016) is related to vineyard management considering sustainability criteria. The method facilitates agronomists in decision-making and more sustainable practices. Moreover, Sabaghi et al. (2016) proposed the use of fuzzy logic, specifically fuzzy-inference system, to evaluate the sustainability of products and processes in different factories. Moreover, according to Gil-Lafuente and Barcellos Paula (2013, p.674) "Fuzzy Logic can be useful in the identification of stakeholders considering sustainability criteria in enterprises" and Vizuete Luciano et al. (2013, p.736) apply "the theory of the forgotten effects with the analysis of the causes or external elements to the Catalonian economy and of the effects or reflections that it produces in the sustainability".

In conclusion, if there was a more comprehensive use of this method, companies could have several benefits, such as the use of a simpler and

effective tool to deal with qualitative data, and facilitate decision making through the dialogue with different interest groups. This constitutes an innovation and a useful tool to be used in the processes of aggregation and unification of contradictory opinions or divergent expectations among the stakeholders. In addition, the model allows knowing the distribution by levels in the characteristic function of belonging of the aggregated values". The following section presents the methodology that will be used in this paper.

3.Methodology

This section presents the "Experton Method" (Kaufmann, 1987). Although Kaufmann (1987) has the most complex and efficient method, others authors have been working on the same subject since the 70´s and have contribute to this theory. Burusco and Fuentes-González (2001) pointed out that the authors (Hirota, 1981; R. Féron, 1976) "developed the concept of random fuzzy sets or probabilistic sets, which allows us to have as a membership function a random variable in [0;1]". Moreover, Sambuc (1975) introduced the definition of -Fuzzy set taking as membership function any interval in [0;1]. Associated with these concepts, Arnold Kaufmann (Kaufmann, 1988; Kaufmann, 1987) defined the expertons as a generalization of the -Fuzzy sets (R. Féron, 1976) and the probabilistic sets (Hirota, 1981). "He chooses the name experton because it stores the opinion of some experts about some properties which are interesting to study" (Burusco and Fuentes-González, 2001). Kaufmann mentioned that "this methodology represents an important extension of fuzzy subsets" and allows including the opinion of several experts on a topic. According to Gil-Lafuente and Barcellos Paula (2010, p. 403) and Paula (2011, p. 512) "it is known that every expert possesses the property of the non-strict horizontal increasing monotony, that is, the characteristic feature of belonging of the positive slope function is less than or equal to the characteristic feature belonging to the negative slope function. And on the other hand, every expert has a non-strict vertical growing monotony, except at level 0, which always takes the value 1". Therefore, it is presented:

$$\forall \alpha \in [0,1]: a_1(\alpha) \leq a_2(\alpha) \text{ in } [a_1(\alpha), a_2(\alpha)] \quad (1)$$

$$\forall \alpha, \alpha' \in [0,1]: (\alpha' > \alpha) \Rightarrow (a_1(\alpha)) \leq a_1(\alpha'), a_2(\alpha) \leq a_2(\alpha')) \quad (2)$$

$$(\alpha = 0) \Rightarrow (a_1(\alpha) = 1, a_2(\alpha) = 1) \quad (3)$$

First, it considered "the valuation of each expert expresses a level of truth by scale of 11 values between 0 and 1 both included that can be explained generically as follows" (Gil-Lafuente and Barcellos Paula, 2010, p. 403; Paula, 2011, p. 513):

0: false	0.6: Truer than False
0.1: practically false	0.7: quite true
0.2: almost false	0.8: almost true
0.3: quite false	0.9: practically true
0.4: more false than true	1: true
0.5: neither true nor false	

Second, the start of the aggregation process leads to the transformation of opinions into a representative of the previous valuation. "The first task will be to obtain the statistics of the opinions to know the time that experts have expressed the same opinion" (Gil-Lafuente and Barcellos Paula, 2010, p. 403; Paula, 2011, p. 513). This result represents the statistics of the experts' opinions and identifies the cumulative frequency of each valuation. Third, "from the obtained cumulative frequency, the calculation of the cumulative relative frequencies for the above values was obtained by dividing the total number of views" (Gil-Lafuente and Barcellos Paula, 2010, p.403; Paula, 2011, p.513). Fourth, with the result the "Experton" is achieved. The importance of this result lies not only in obtaining the relative frequencies assigned to the characteristic feature of belonging, but also allows knowing the distribution and tendency of subjective opinions. The result expresses all the experts' opinions on the subjects considered in a given study.

"The Experton is itself an aggregate view representative of all that have been considered in the sample. In order to give a simplified representation of an Experton, it can be used to obtain the mathematical expectation. All operators can be used with variable or confidence intervals in [0,1] can also be used Experton, and these operations are valid for any number of Experton" (Gil-Lafuente and Barcellos Paula, 2010, p. 403; Paula, 2011, p. 513). According to Paula (2011, p. 207) "this methodology can facilitate decision making by obtaining qualitative data from the dialogue with different interest groups. This constitutes an innovation and a useful tool to be used in the processes of aggregation and unification of contradictory opinions or divergent expectations among its stakeholders. In addition, the model allows knowing the distribution by levels in the characteristic

function of belonging of the aggregated values". The following section presents an application of the methodology.

4.An application of the "Experton Method"

This section presents an application of the "Experton Method" to prioritize relevant issues of the stakeholders of a multinational sports company. The name of the company will not be disclosed for confidentiality reasons. This company is dedicated to the manufacture of footwear, sportswear and other products related to sport and fashion. The company employs more than 60,000 people in over 160 countries, and produces more than 850 million product units each year. It seeks to know the stakeholders' expectations in compliance with the contents of the sustainability report and (Global Reporting Initiative, 2016a). It analyzes the relevant issues or materials of a multinational company that manufactures footwear and sportswear through a survey.

The GRI defines material topic as the "topic that reflects a reporting organization's significant economic, environmental and social impacts; or that substantively influences the assessments and decisions of stakeholders" (Global Reporting Initiative, 2016b). It is recommended that the company involves several stakeholders during the reporting process and that employers can listen to them actively. In this way, the process gains legitimacy, transparency and important contributions from stakeholders. In this case, the stakeholders are: Analyst, Investor, NGO (Non-Governmental Organisation), Academic, Consultant, Media, among others. The main objective of the company is to analyse five issues, evaluate them, receive comments and suggestions from stakeholders and, if possible, assume some commitments related to the following issues: ethical business practices; forced labour carbon footprint (supply chain); supply chain transparency; and disciplinary practices. They have been chosen by the company in order to reduce risk and amplified the stakeholders dialogue. Figure 3 shows these five issues and each issue is described below.

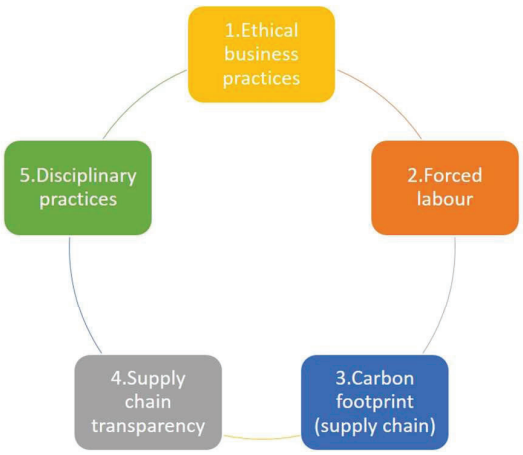

Figure 3. Material issues.
Source: Own source (2018)

According to Turyakira (2018) "business ethics is basically the study of morality and standards of business conduct". The same author indicates that "business ethics denotes the application of ethics to business practices (Twomey and Jennings, 2011) and highlights it is simply the application of general ethical rules to business behaviour (Hodgelts and Luthans, 2003). Furthemore, ethical practices are the conscious compliance with the standard of morality that guides an individual and business to follow certain norms of conduct when dealing with people within and outside the organisation (Ononogbo et al., 2016)". In summary, a socially responsible company must claim ethical practices from the suppliers. In this way, the firm manages the reputational risks and guarantees a better result of the supply chain.

Forced labor represents an important issue in the company's supply chain. The stakeholders, i.e. consumers, media and NGOs, are observant and pressure the proper behaviour of companies on this issue. "The term forced or compulsory labour shall mean all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily"(International Labour Organization (ILO) Convention 29, 1930). According to Awaysheh and Klassen (2010) "firms with international supply chains reaching into developing countries have increasingly adopted standards, such as SA8000, that set basic

requirements for workforce practices in internal operations and in multiple tiers of suppliers (Social Accountability International, 2008)".

According to Balaguera et al. (2018) "carbon footprint is a method used to quantify the amount of greenhouse gas emissions associated with a company or with the life cycle of an activity or a product/service in order to determine its contribution to climate change". There are several ways to measure the carbon footprint. The most important are: ISO 14064 is a strategy for reducing the carbon footprint and ISO 14065 is a carbon footprint compensation strategy. Another tool used is the life cycle analysis (LCA). This tool rigorously analyses the environmental impact in all the production process stages. By using the life cycle methodology, the company can identify the carbon footprint from the raw material to the disposition of the finished product. This analysis helps the company in its decision-making to improve processes, products and services. Through these initiatives, the strategy of sustainable development follows the direction of responsible and competitive action, which goes beyond the limits of the industrial units and involves the company's productive chain. "Therefore, a sustainable company must apply a policy with carbon reduction considerations in the supply chain" (Balaguera et al., 2018; Tang et al., 2018).

To Zhu et al. (2018) "a transparent supply chain relies heavily on information about products as they move through the chain". In the same way, the authors (Morgan et al., 2015) name this "operational supply chain transparency (OSCT), which is defined as a firm's capability to proactively engage in communication with stakeholders to obtain visibility and traceability into upstream and downstream supply chain operations". Zhu et al. (2018) concluded that "the information garnered from such communication needs to be accurate, timely, consistent and complete" (Hazen et al., 2014) and "structured in a fashion that is usable to supply chain stakeholders" (Spekman et al., 1998). To Awaysheh and Klassen (2010) "Transparency has become increasingly important for social issues, including the origins of commodities and product safety (Lee, 2002; van Der Zee and van Der Vorst, 2005)". For these reasons, it is justified to include this transparency issue to evaluate the supply chain.

Awaysheh and Klassen (2010) propose that socially responsible practices of suppliers must include four dimensions: supplier human rights, supplier labour practices, supplier codes of conduct, and supplier social audits. The same authors stated that "Supplier human rights measure the extent to which practices are in place to reduce the possibility that suppliers employ vulnerable groups of people, such as children. Supplier labour practices

assesses the conditions in which employees perform their duties, and how an employer contributes to the overall welfare of employees. Supplier codes of conduct measures the extent to which specific procedures are explicitly spelled out by the focal firm to ensure that suppliers adhere to ethical expectations. Finally, the supplier social audits measure the degree to which suppliers are monitored by the focal firm to ensure their adherence to social expectations" (Awaysheh and Klassen, 2010). Thorne and Quinn, (2016) described that "codes of conduct are often found in production or service arrangements with suppliers in countries where rights and laws are not strictly enforced". Therefore, this action serves for the enterprise to manage the practices of suppliers and reduce risks. In summary, disciplinary practices and code of conduct (Graafland, 2002; Thorne and Quinn, 2016) are fair procedures for employers and employees and, in this way, companies can evaluate their supply chain through this issue. Next, the algorithm application is presented in five stages.

First step: seven specialists are inquired about the importance of sustainability issues via an online survey, and asked to indicate their point of view according to a scale [0,1], whereby the closer the estimate is to 1, the better the meeting the stakeholders' expectations in the following items:

1-Ethical business practices
2-Forced labour
3-Carbon footprint (supply chain)
4-Supply chain transparency
5-Disciplinary practices

This approach is based on real company data and the results allow us to reflect on the importance of sustainability and the application of algorithms to facilitate decision-making. Therefore, the usefulness of its application and results are important both at an academic and business level. According to the collected data, the points of view of seven experts are obtained, as shown in Table III.

Table III. Views of seven experts

Expert	*Valuation*				
	1	***2***	***3***	***4***	***5***
1	*0.8*	*0.8*	*0.6*	*0.8*	*0.6*
2	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*
3	*0.7*	*0.8*	*0.8*	*0.7*	*0.6*
4	*0.7*	*0.8*	*0.4*	*0.6*	*0.6*
5	*0.7*	*0.8*	*0.6*	*0.8*	*0.6*
6	*0.6*	*0.8*	*0.8*	*0.8*	*0.4*
7	*0.8*	*0.8*	*0.6*	*0.8*	*0.6*

Second step: get the statistics of the experts' opinions and identify the cumulative frequency (CF) of each valuation as shown in Table IV. For example, issue 1 received the 0.7 rating three times.

Table IV. Cumulative Frequency (CF)

	1		*2*		*3*		*4*		*5*	
	CF	*Nº times*	*CF*	*Nº times*	*CF*	*Nº times*	*CF*	*Nº times*	*CF*	Nº times
0	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*
0.1	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*
0.2	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*
0.3	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*	*7*	*0*
0.4	*7*	*0*	*7*	*0*	*7*	*1*	*7*	*0*	*7*	*1*
0.5	*7*	*0*	*7*	*0*	*6*	*0*	*7*	*0*	*6*	*0*
0.6	*7*	*1*	*7*	*0*	*6*	*3*	*7*	*1*	*6*	*5*
0.7	*6*	*3*	*7*	*0*	*3*	*0*	*6*	*1*	*1*	*0*
0.8	*3*	*3*	*7*	*7*	*3*	*3*	*5*	*5*	*1*	*1*
0.9	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
1	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Third step: calculate the cumulative relative frequencies, which is obtained by dividing the previous values by the total number of views; in this study are seven. The results are presented in table V.

Table V. Cumulative relative frequencies

	Relative frequencies				
	1	**2**	**3**	**4**	**5**
0	*1*	*1*	*1*	*1*	*1*
0.1	*1*	*1*	*1*	*1*	*1*
0.2	*1*	*1*	*1*	*1*	*1*
0.3	*1*	*1*	*1*	*1*	*1*
0.4	*1*	*1*	*1*	*1*	*1*
0.5	*1*	*1*	*0.9*	*1*	*0.9*
0.6	*1*	*1*	*0.9*	*1*	*0.9*
0.7	*0.9*	*1*	*0.4*	*0.9*	*0.1*
0.8	*0.4*	*1*	*0.4*	*0.7*	*0.1*
0.9	*0*	*0*	*0*	*0*	*0*
1	*0*	*0*	*0*	*0*	*0*

Fourth step: the consolidated information is obtained in what is called "Experton". The result expresses the opinions of all the experts on the subjects that have been considered in this study. The expected value is obtained to simplify the final result, as shown in Table VI.

Table VI. Expected value

Expected value	
$\varepsilon 1 =$	*0.73*
$\varepsilon 2 =$	*0.80*
$\varepsilon 3 =$	*0.66*
$\varepsilon 4 =$	*0.76*
$\varepsilon 5 =$	*0.60*

Finally, the most relevant topics can be ordered according to the opinions of the stakeholders. Figure 4 shows the results of the study.

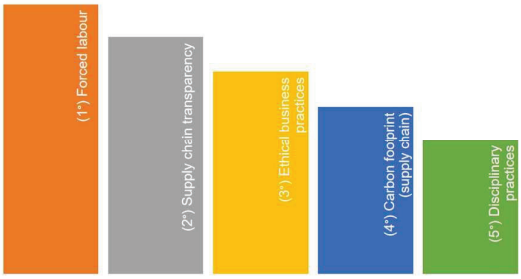

Figure 4. Ranking of the most relevant issues
Source: Own elaboration (2018).

The presentation of the results can also be expressed in a matrix of materiality (Global Reporting Initiative, 2016c). The materiality principle "identifies material topics based on the following two dimensions: the significance of the organization's economic, environmental, and social impacts; and their substantive influence on the assessments and decisions of stakeholders"(Global Reporting Initiative, 2016d). Figure 5 shows the results that take into account the criteria of impact and relevance for the company.

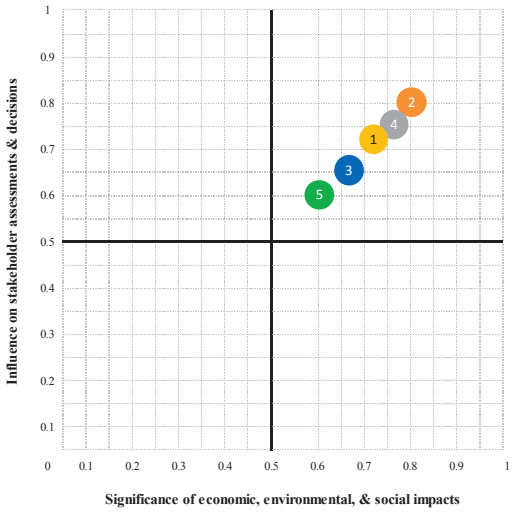

Figure 5. Matrix of Materiality
Source: Own elaboration (2018).

Figure 5 shows that issue 2 (Forced labor) has greater impact and influence for the enterprise. Issue 4 (Supply chain transparency) is in a second level of impact and influence. Next, it is observed that issue 1 (Ethical business practices) is in a third place, issue 3 (Carbon footprint supply chain) is in a fourth place, and finally issue 5 (Disciplinary practices). The result allows the enterprise to establish an order of priority to manage each of these issues. This model used can be adapted and expanded according to the needs of companies, such as the requirements of the questions, the number of experts involved, include other topics such as environmental and social, and apply to other sectors of the economy. The algorithm used can help decision makers in processes that include the stakeholder's opinions and, in this case, a tool that treats qualitative data in a reliable manner is required.

The methodology used allowed knowing the stakeholders expectations and defining priorities in sustainability issues. On the other hand, the paper shows that if stakeholders are included in the decision-making process, the company generates trust and legitimacy of its stakeholders. This participatory approach and the use of algorithm helped companies in the materiality assessment, definition of priority issues, and management of resources. Specifically in this case, this application method allows the company to prioritize issues and generate legitimacy of stakeholders, as well to claim ethical practices from suppliers, and to reduce the reputational risk. All of this can be achieved by addressing the police to protect environment, implementing an ethical conduct about workforce, conducting traceability on the supply chain, and implementing conduct codes.

5.Future research

The developed bibliometric study identifies knowledge gaps and opportunities to propose future lines of research on the subject, such as, decision-making related to the identification, prioritization and dialogue of stakeholders, grouping of opinions, definition of relevant topics or materiality, strategic management with stakeholders, choice and definition of sustainability projects, among others. Extending the search based on this algorithm may help companies to deal with big data and treat information in a context where there is a vast quantity of information and we need to deal with different expectations. And, above all, to contribute to increase the advantages of competitive companies since these can prioritize actions

and optimizing resources. As we have seen before, the "Experton Method" is very efficient when processing contradictory opinions or divergent expectations, as it can classify values by levels. In summary, it is a valuable tool for decision makers who need to include the stakeholders' opinions in their sustainability strategies. Also, the conceptual study contributes to scientific knowledge and can support future research in this field.

6.Conclusions

Based on the study results, the following conclusions are drawn.

First, stakeholder management is essential to achieve corporate sustainability; however, that is not an easy task for companies due to constant changes and competitiveness in the markets. For these reasons, this paper seeks to deepen the discussion on sustainability in companies through a literature review. With a bibliometric study, knowledge gaps on the subject were identified.

Second, the "Experton Method" methodology was presented. It is a tool that facilitates aggregating opinions on various topics, and can be very useful in the stakeholder management. It also involves the participation of stakeholders, and generates trust and legitimacy in the reporting process. Third, the "Experton Method" was applied to prioritize the relevant issues of the stakeholders of a sports company that prepared its sustainability report. The study considers the opinions of seven stakeholders on five economic issues. The result indicates an order of relevance of the issues, such as, Forced labour (1°), Supply chain transparency (2°), Ethical business practices (3°), Carbon footprint (supply chain) (4°), and Disciplinary practices (5°). This result allows the company to establish an action plan for each issue. Fourth, the results confirmed the validity and utility for companies in the decision-making processes. Therefore, its application can directly contribute to the business environment since it is a valid tool for defining priorities and optimizing resources, thus increasing the competitive advantage of companies.

Furthermore, there is a great scientific contribution proposing and applying Fuzzy Logic in Sustainability, which is the main gap in literature and it is a major contribution in this paper. Through this paper, with the application of fuzzy logic models to deal with the management of sustainability in companies, the intention is to add to the ongoing scientific studies and to awaken the importance of more scientific studies on decision making.

In summary, this paper provides theoretical applications with the literature review on corporate sustainability, indicating that companies seeking sustainable development must consider the stakeholder´s engagement in its strategies, the usefulness and contributions of fuzzy logic to the sustainable development of companies. Based the bibliometric study, the knowledge gaps on the subject are shown. In addition, a proposal that uses an algorithm of fuzzy logic applied in the supply chain management is presented. For these reasons, an important contribution is observed at the academic level for expanding the frontier of knowledge on the subject.

In terms of managerial implications, this paper introduces a useful tool that can help entrepreneurs in the decision making process to manage their suppliers. It has a range of benefits because it is a simpler and effective tool that deals with qualitative data and facilitates decision making through the dialogue with different stakeholders. With this method we are contributing to increase corporate competitiveness and to optimize resources, as they get to prioritize actions. The proposed model can be applied to different industries, companies of various sizes and geographic location. It also allows reducing subjectivity, generating greater precision and decreasing the risk in decision making. Finally, this paper aims to increase awareness of entrepreneurs and society about corporate sustainability.

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