Sustainable procurement practices in the brazilian chemical industry context

Práticas de compras sustentáveis no contexto da indústria química brasileira

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Abstract

Sustainable procurement requires an understanding of the full impact of purchase throughout the entire life cycle of the product or service, irrespective of location. The aim is to investigate the adoption of sustainable procurement in some Brazilian chemical companies. Questionnaires were sent to professionals from the Brazilian Chemical Industry Association (ABIQUIM) and from thirty-seven associated companies. The results were used to elaborate empirical illustrations about sustainable procurement practices in the Brazilian chemical industry context. Although the companies did not have a prescriptive supplier selection model that incorporates social-environmental criteria, most companies had more restrictive standards than the legislation and they supported suppliers to improve their social-environmental performance. In addition, that actions related to social and environmental issues occur in policies and documents and are reflected through middle and upper management commitments. It indicates that there are some organizational directions to incorporate social and environmental questions. However, no materialization in actions along the procurement process.

Keywords: Sustainable procurement. Chemical industry. Regulation, developing countries, Brazil.

Resumo

As compras sustentáveis tratam do impacto total da compra durante todo o ciclo de vida do produto ou serviço, independentemente da localização. O objetivo deste artigo é investigar a adoção de compras sustentáveis em algumas empresas químicas brasileiras. Foram enviados questionários a profissionais da Associação Brasileira da Indústria Química (ABIQUIM) e a trinta e sete empresas associadas. Os resultados foram utilizados para elaborar ilustrações empíricas sobre práticas de compras sustentáveis no contexto da indústria química brasileira. Embora as empresas não tivessem um modelo prescritivo de seleção de fornecedores que incorporasse critérios socioambientais, a maioria das empresas possuía padrões mais restritivos do que a legislação e apoiava os fornecedores para melhorar seu desempenho socioambiental. Além disso, as ações relacionadas a questões sociais e ambientais ocorrem em políticas e documentos e são refletidas por meio de compromissos da média e alta gerência. Isso indica que existem algumas orientações organizacionais para incorporar questões sociais e ambientais. No entanto, não há materialização nas ações ao longo do processo de compras.

Palavras-chave: Compras sustentáveis. Indústria química. Regulamentação. Países em desenvolvimento. Brasil.

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

1 Introduction

Procurement is a key sector and policy area in which entities and countries can, and increasingly do, seek to promote environmental and social sustainability. Procurement should embody the underlying characteristics of efficiency (i.e., transparent, fair, non-discriminatory, competitive, accountable, efficient use of public funds) but also integrate the three dimensions of sustainable development: social, environmental, and economic. Thus, sustainable procurement requires an understanding of the full impact of a purchase throughout the whole life cycle of a product or service, irrespective of location, from the sourcing of natural resources to end-of life management (e.g., reuse, recycle, and disposal) (Govindan, Rajendran, Sarkis, & Murugesan, 2015).

Both public and private sector organizations use sustainable procurement to ensure purchasing reflects broader goals linked to resource efficiency, climate change, social responsibility and economic resilience. To achieve the goal of sustainable procurement, one of the main challenges faced by governments and other organizations is to implement sustainable development in their operations and work collaboratively with suppliers by developing relationships that minimize negative social, economic and environmental impacts in the public procurement process. Studies highlight that procuring agencies and companies increasingly position sustainable procurement in a central role (Appolloni, Sun, Jia, & Li, 2014; Mosgaard, 2015; Flammer, 2018). However, the integration of the environmental and social aspects into the procurement supply chain remains a challenge due to cost, quality, dependability and flexibility considerations (Ghadimi, Wang & Lim, 2019; Zimmer, Fröhling, & Schultmann, 2016).

Although a wide variety of studies establishes environmental and social criteria for suppliers' selection. It is also important to highlight that companies are increasingly facing alarming incidents of non-compliance regarding sustainability (Fiaschi, Giuliani, & Nieri, 2015; Wilhelm, Blome, Bhakoo, & Paulraj, 2016; Jamali & Karam, 2018). Thus, Govindan et al. (2015) argue that additional research is required to identify and more clearly define each of the criteria.

The widespread presence of the chemicals in everyday activities provides benefits to societies' wellbeing, but at the same time might have some harmful results especially related to the environmental and social impacts. According to Lozano et al. (2018) in order to reduce such results, green chemistry, green engineering, eco-efficiency, and sustainability are becoming a requirement for assessing and managing products and processes in the chemical industry.

In this paper, the aim is to investigate the adoption of sustainable procurement in some Brazilian chemical companies. The paper is structured in four sections. The introduction is followed by theoretical background about sustainable procurement, a brief description about chemical industry

and the Responsible Care programme in Brazil. Further, it is presented the results and discussion, and final considerations.

2 Sustainable procurement

Sustainable procurement requires managers to purchase goods and services from not only the lowest cost suppliers but also from those that provide value for money, short and flexible delivery time, and are capable of managing the social and environmental aspects associated with the production process (Krause, Vachon, & Klassen, 2009; Hussain, Al-Aomar, 2017). From the operations point of view, the challenge is deploying the social and environmental practices regarding of operations (Gimenez, Sierra, & Rodon, 2012; Sodhi, 2015).

The literature provides evidence that sustainable procurement requires consideration of economic, environmental and social consequences when making buyer selection decisions (Kalubanga, 2012; Zhou & Xu, 2018). According to Brammer and Walker (2011), the first step towards sustainable procurement is acknowledging the importance of information. Their survey finds that nearly 83% of European governments' public procurement professionals are challenged to deliver sustainable purchasing solutions. This finding suggests the importance of equipping professionals with the capacity to deliver innovative solutions and perform in-depth assessments of economic performance, as well as of the environmental and social impacts of procurement.

Therefore, the implementation of a sustainable supply policy depends on the procuring agencies' appreciation of and policy focus on environmental and social issues, as well as on in-house expertise. The supplying and procuring departments are key players in an organization's ability to achieve sustainability objectives and establish minimum standards for the supply and monitoring of procurement activities (Appolloni et al., 2014; Mosgaard, 2015; Ghadimi, Wang & Lim, 2019). As a result, leading companies incorporate sustainability to increase the environmental consciousness of their procurement supply chains. Bowen, Cousins, Lamming, and Farukt (2001) found a positive co-relation between a proactive corporate environmental strategy and the development of supply department capabilities for the implementation of sustainable suppliers. However, the capacity development that allows suppliers to respond to opportunities occurs over time and is a complex process. Furthermore, with regards to building capacity through training and qualifications, Pagell and Wu (2009) and Tate, Ellram, and Dooley (2012) suggest that qualifications should go beyond an organization's limits and must focus on building awareness among suppliers. Tate et al. (2012) propose that the buyers impose environmental criteria on suppliers as a pre-requisite; this must be collaborative and include training for suppliers to support them in developing socio-environmental criteria. Due to the growing importance of sustainable procurement via sustainable supply chains, the

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

support of administration and senior management is a pre-requisite (Bowen et al., 2001; Defra, 2006; Mosgaard, Riisgaard, & Huulgaard, 2013). Thus, a sustainable strategy backed by political should include a holistic definition of the responsibilities, resources, and appropriate monitoring procedures along the supply chain. Mosgaard (2015) argues that sustainable procurement can be perceived as an organizational competency by shifting knowledge into practice. Meehan and Bryde (2011) highlight that enhancing sustainable corporate direction supports the supply function for companies incorporating the economic, social and environmental perspectives.

Studies highlight that procurements do not always comply with minimum social and environmental standards, which might pose a high risk of non-conformity with sustainable procurement norms (Walker, Miemczyk, Johnsen, & Spencer, 2012). In light of the increasing legal strictness of environmental and social norms, it is critical to adhere to sustainable requirements in purchasing goods and services (Brammer & Walker, 2011; Jabbour & Jabbour, 2016; Meehan & Bryde, 2011; Zhu, Geng, & Sarkis, 2013). Later, emphasis has shifted from price-based supplier selection to innovation in supply chains and the incorporation of social and environmental considerations (Carter & Jennings, 2004). Thus, the introduction of socio-environmental requirements in purchasing requires instruments, techniques, and models that allow the purchaser to deal systematically with added complexity while also ensuring the effectiveness of the purchase.

Bai and Sarkis (2010) discuss the environmental selection factors in procurement practices and performance. While practices refer to policies and procedures, performance addresses suppliers' measurable environmental aspects. Humphreys, Wong, and Chan (2003) analyse the criteria from the suppliers' perspective to address pollution costs and the stress corresponding to the need to review the acquisition cost of materials and services from a wider approach, that includes all costs incurred along the products' life cycle, i.e., acquisition, operation, maintenance and disposal costs (Defra 2006). While some products have lower acquisition costs, the operation and maintenance costs of residue disposal might vary and are based on the toxicity of a product. As a result, some buyers focus on short term benefits, resulting in environmental degradation (Geng & Doberstein, 2008).

The following environmental factors are highlighted for their effect on the electronic, automotive and paper industries: green material selection, green design, remanufacturing/reuse activities, environmental management information, waste management, cost of pollution effects, carbon footprint, etc. (Chiou, Hsu, & Hwang, 2008; Govindan et al., 2015; Lee, Kang, Hsu, & Hung, 2009; Vahidi et al., 2018). This makes it imperative for suppliers' selections to be based on quantifiable criteria from an environmental perspective (Handfield, Walton, Sroufe, & Melnyk, 2002). For example, these criteria could include ISO 14001 Certification, i.e., the use of substances harmful to the ozone layer, recyclable content, presence of volatile compounds, suppliers listed as users of hazardous/dangerous substances by environmental protection agencies/authorities, remanufacture and reuse activities, use of returnable packaging, reverse logistics, environmental track records.

Others list the incorporation of pollution control and prevention, as well as the use of resources and green products. In these terms, certification is an important tool supporting buyers to mitigate and manage the risks related to social and environmental issues.

Social factors may be categorized into internal and external factors. Whereas internal features refer to practices related to employment, such as gender diversity and labour law compliance, external features refer to the relationships with contracted persons, suppliers, local communities and non-governmental organizations. Studies show that social criteria include safety policies, fair labour relations, activity in the local community, donations, and commitment to NGOs (Bai & Sarkis, 2010; Humphreys et al., 2003).

From the literature review it was elaborated some constructs for investigating the dimensions of sustainable procurement (Table 1). They are organizational orientation and supplier selection. The supplier's selection criteria is both quantitative and qualitative. The former classification refers to costs and monetary terms, while the qualitative classification is subjective and depends on the company's view of sustainability (Kalubanga, 2012). Bai and Sarkis (2010) and Sarkis and Talluri (2002) classify supplier selection by strategic performance measures and organizational factors. The strategic performance measures and variables include price, quality, compliance, delivery and innovativeness. In organizational terms, these relate to culture, such as feeling of trust, management attitude, technology compatibility, and long-term relationships. Regarding environmental metrics, pollution control and prevention and environmental management systems are of the most importance. Other metrics relate to social and resource consumption. For instance, social metrics include employment practices, health and safety, and the importance of local communities'and stakeholders' influence. Other resources that are used to indicate the social-environmental behaviour of suppliers are seals, certifications and listings of enterprises with superior environmental and social performance (Geng & Doberstein, 2008; Pagell & Wu, 2009; Zhu et al., 2013). One example is the ISO 14001, which contains a series of environmental standards that provide companies with "uniformity in implementing an environmental management system" (Ferrell & Ferrell, 2016).

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

Table 1 - Constructs, dimensions and literature

CONSTRUCTS	DIMENSIONS	LITERATURE
Organizational Orientations	Upper management support	Bowen et al. (2001), Defra (2006), Meehan and Bryde (2011), and (Mosgaard et al., 2013).
	Development of sustainable supply systems and models	Genovese et al. (2013), Ghadimi et al. (2016) and Govindan et al. (2013).
	Inclusion of the supply area in the sustainability process development	Appolloni et al. (2014), Mosgaard (2015), and Zimmer et al. (2016).
	Supply area, human resource skills and competencies development	Brammer and Walker (2011).
	Support suppliers in their social-environmental performance improvement efforts (cooperation)	Corbett and Klassen (2006), Pagell and Wu (2009) and Tate, Ellram, and Dooley (2012)
Supplier selection criteria	Traditional criteria: price, quality, quantity, delivery, compliance, innovativeness, long-term relationship.	Zimmer, Fröhling, and Schultmann (2016); Bai and Sarkis (2010)
	Socio-environmental criteria: The energy matrix and the amount of energy used for production, generation of greenhouse effect gases, volume of water used for the production of given supply, ozone layer-harmful emissions, generation of dangerous and non-dangerous waste, total cost of product's life cycle, pollution control, complaints on suppliers using child/slave labour or identical conditions, work accidents reported and complaints from the community about premises, environmental management system, local community influence.	Bowen et al. (2001), Brammer and Walker (2011), Chiou, Hsu, and Hwang (2008), Govindan et al. (2015), Jabbour and Jabbour (2016), Meehan and Bryde (2011), Zhu, Geng, and Sarkis (2013) and Sarkis and Talluri (2002).
	Cultural criteria: feeling of trust, management attitude, technology compatibility, long-term relationship	Sarkis and Talluri (2002)
	Certificates and environmental seals	Geng and Doberstein (2008), Pagell and Wu (2009), and Zhu, Geng, and Sarkis (2013).

Source: Authors' compilation.

3 The chemical industry in the Brazilian context

In 2003, the Brazilian Labour Ministry created a "dirty list" to identify the use of unsustainable activities. The 'Brazilian Institute for Environment and Renewable Natural Resources' (IBAMA), termed the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, has a list of activities banned by the agency as environmental crimes (e.g., listed activities cannot be used for restoration), and dictates that entities that buy products from this list are subject to penalties. Furthermore, a number of international organizations have promoted guidelines and principles for environmental management in Brazil. These include the International Chamber of Commerce (ICC), the Business Council for Sustainable Development (BCSD), the Confederation of British Industry (CBI), the Coalition for Environmentally Responsible Economies (CERES), the Global Environmental Management Initiative (GEMI), and the International Standards Organization (ISO).

In the chemical industry, the Responsible Care programme was established by the American Chemical Industries Association in 1988 and is coordinated by the Brazilian Chemical Industry Association (ABIQUIM). Under this programme, participating industries must improve performance in

health, safety and environmental quality. Such management practices relate to emergency responses, pollution prevention, process safety, chemical product distribution, and the health and safety of products along their lifecycle (product stewardship).

4 Methodology

In order to identify the sustainable procurement practices in the Brazilian chemical industry context we adopted a quantitative approach. Data were collected using a questionnaire comprised of 28 questions (see Appendix 1). The first three questions are used to characterize the supplier and the product provided. Four questions are phrased as statements, and the answer is either agree or disagree; ten are questions with yes or no answers; ten are questions with responses on a 4-point Likert scale (always, most times, seldom, and never); and one is a question ranking suppliers' selection criteria on a scale from 1 to 10 (from less important to most important).

At November 2015, a first version of the questionnaire was submitted for validation to eighteen procurement professionals (procurement managers and analysts) from three large chemical companies located in Brazil. According to Forza (2002), the first phase of questionnaire applications must be applied to a small sample of potential respondents to clarify if instructions and questions are clear enough. After this first phase, a discussion with the respondents was conducted and small changes in the questionnaire were made.

The research was also presented to professionals from ABIQUIM for collecting information about Responsible Care Programme and sustainable procurement practices of Brazilian chemical industry. In addition, the Supply Sector Commission at ABIQUIM provided the sample contacts. Furthermore, additional supply-connected professionals were identified through the LinkedIn network.

At February and March 2016, the questionnaires were distributed to the respondents using conventional mail followed by telephone calls in order to increase the response rate. The researchers sent invitations (by email) to 131 analysts and procurement managers from 38 chemical industries. A total of 93 professionals accepted the invitation, and 37 answered the submitted questionnaire, a response rate of 39,7%. About 41% of respondents were procurement managers. The data was managed and analysed thought SPSS 23.0 software.

It was used non-parametric tests, such as the Mann-Whitney, Spearman's test and the test for proportion, because the data did not meet some of the necessary assumptions to develop parametric tests. According to Siebert and Siebert (2018) the choice of non-parametric methods relies on the limitations of the data because they do not meet the assumptions of the parametric methods or even when the samples are small. In addition to relying on few or no assumption about the shape or

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

parameters of the population distribution, an important advantage of non-parametric procedures is that they can be applied using nominal and ordinal data, and are not dependent only on the range and reason variables (Siebert & Siebert, 2018).

When the intention is to determine if there are differences between two groups in a continuous or ordinal dependent variable, the Mann-Whitney test is used. This test is a nonparametric version equivalent to the independent samples t-test (Field, 2013).

A correlation is a measure of the linear relationship between variables (Hair Jr, Black, Babin, & Anderson, 2014; Johnson & Wichern, 2007). When the correlation is between two variables, the Pearson coefficient or Spearman's rho test is used as coefficients of bivariate correlation (Field, 2013; Hair Jr et al., 2014). As a nonparametric alternative to the Pearson coefficient, Spearman's correlation coefficient is a statistic that can be used when the data violate parametric assumptions (Field, 2013, Hair Jr et al., 2014, Tuomisto, Hodge, Riordan, & Macdonald, 2012)

Finally, a test for proportion was carried out to aiming to test if the number of positive answers is significantly higher than the number of negative answers. According to Sweeney, Williams, and Anderson (2013) and Daniel (2009) a test for proportion are based on the difference between the sample proportion and the hypothetical population proportion.

5 Results and discussion

In the research questionnaire, questions 4 to 14 were designed to obtain information about organizational orientation (Appendix 1). For these questions, a test for proportion was carried out to identify which sustainability-related managerial initiatives are the best in the chemical industry. The objective was to test if the number of positive answers is significantly higher than the number of negative answers (e.g., above 50%). The conclusions were drawn using a significance level of 1% (α).

According to the respondents' responses to questions 4 to 12, the key findings are as follows:

i. 84% of enterprises consider social-environmental questions in their purchase decisions (p=0.971) and 100% agree that socio-environmental questions influence their purchase decisions.

ii. 95% (p=0.971) of enterprises agree that the organization is undertaking actions to add social-environmental subjects to their purchasing activity.

iii. 75% (p=0.924) of enterprises have a written policy regarding socio-environmental issues.

iv. 84% (p=0.971) of enterprises have leadership committed to addressing social-environmental issues.

v. 70% (p=0,971) of interviewees received some training related to sustainable practices in their enterprise.

vi. 68% (p=0.955) of the enterprises have sustainability goals in their procurement activities.

vii. 60% (p=0.174) of enterprises support suppliers to improve their social-environmental performance.

viii. The factors of adopting sustainability goals for the purchasing function and the presence of partners (such as NGOs) to incorporate social and environmental features to the purchasing function were not significantly higher than 50%. As such, it is not possible to state that the majority of enterprises adopt sustainability goals for the purchasing function (p=0.016) or that the majority of enterprises have partnerships that support the incorporation of those aspects (p=0.125).

Although the result shows a high score for sustainability, with increasing weight on purchasing decisions, it also confirmed a lower score regarding the influence of sustainability on current purchasing decisions. Such results depict organizational inertia and the complexity of integrating sustainability into the supply chain, as noted by Pagell and Wu (2009) and Testa, Iraldo, Frey, and Daddi (2012).

Furthermore, managerial initiatives relating to sustainability in supply are connected to existing written policies, support and commitment from higher and middle management, and training aimed towards social-environmental elements. The values observed for initiatives on social-environmental goals and partnerships with NGOs are significantly above 50% (p = 0,125). In other words, the results indicate that in regard to managerial initiatives in the purchasing areas of the Brazilian chemical industry, cooperation with NGOs is still incipient.

Questions 13 to 16 were designed to obtain information about suppliers' requirements and purchasers' training regarding social-environmental questions (according to Appendix 1). For these questions, a test for proportion was carried out at a significance level (α) of 1%. The key findings are as follows:

i. The number of positive answers, such as "I believe I am technically prepared to include and evaluate social and environmental aspects in my supplier´s selection," was not significantly above 50% (p= 0.016).

ii. 100% of the interviewees did not have a prescriptive supplier selection model that incorporates social-environmental criteria.

iii. More than 50% of enterprises had more restrictive standards than the legislation in effect (p=0.629).

iv. 70% (p = 0.971) of enterprises supported suppliers to improve their social-environmental performance.

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

The results demonstrate the effect of a lack of training on social-environmental criteria of the professionals in charge of purchasing, despite upper management's focus on social-environmental questions. In this aspect, it is noted that strategic decisions are not supported by tactical decisions that would involve, for instance, the training of supply managers on social-environmental questions. Furthermore, there is no prescriptive supplier selection model that incorporates social-environmental criteria in the Brazilian chemical industry.

Another finding is that legislation is a driving force for social-environmental good practices. The chemical industry acts defensively regarding social-environmental criteria (i.e., it merely complies with the law). When checking if buyers support their suppliers to improve their social-environmental performance, 70% of the respondents confirm their support but only in the provided information on specific legislation and industrial rules, which is about "what to do" instead of "how to do." Thus, there is limited evidence that procurement departments are actively involved and cooperate with their suppliers.

To analyse questions 17 to 27, the Mann-Whitney U test was applied to the social and environmental criteria being taken into consideration for supplier selection (questions 18 to 27), as well as to check whether certification is needed (question 17). Non-parametric statistics are used because the variables were ordinals (Hart, 2001) and they do not follow a normal distribution. Table 2 shows that all the variables scores were not normaly distributed for both Yes and No, as assessed by Kolmogorov-Smirnov's test (p < 0,01), excepted for the Info Denunciations scores for No (p>0,01).

Table 2 - Tests of Normality

VARIABLES	CERTIFICATIONS FOR SUPPLIERS SELECTION	KOLMOGOROV-SMIRNOV[a]			SHAPIRO-WILK		
		Statistic	df	Sig.	Statistic	df	Sig.
Info Energy	Yes	,251	20	,002	,800	20	,001
	No	,428	14	,000	,627	14	,000
Info Emission Gases	Yes	,225	20	,009	,803	20	,001
	No	,478	14	,000	,516	14	,000
Info Water	Yes	,252	20	,002	,795	20	,001
	No	,478	14	,000	,516	14	,000
Info Gases.O3[b]	Yes	,226	20	,009	,816	20	,002
Info Residues	Yes	,225	20	,009	,866	20	,010
	No	,478	14	,000	,516	14	,000
Info Effluents	Yes	,226	20	,009	,867	20	,010
	No	,510	14	,000	,428	14	,000
Info ACV	Yes	,263	20	,001	,800	20	,001
	No	,466	14	,000	,545	14	,000
Info Denunciations	Yes	,416	20	,000	,610	20	,000
	No	,218	14	,071	,857	14	,028
Info Accidents	Yes	,338	20	,000	,787	20	,001
	No	,292	14	,002	,784	14	,003
Info Complaints	Yes	,227	20	,008	,886	20	,023
	No	,389	14	,000	,688	14	,000

Note: a. Lilliefors Significance Correction. b. Info Gases.O3 is constant when certifications for suppliers selection = No. It was omitted

The test was used to verify the difference between "companies using certifications for suppliers selection and companies not using certifications", in relation to the frequency at which, when selecting suppliers, they try to obtain information about the energy matrix and quantity of energy used for production, (Info Energy), greenhouse effects and gas emissions (Info emission gases), water volume used to produce the supply (Info water), harmful ozone layer emissions (Info Gases.O3), dangerous and non-dangerous wastes generated (Info residues), quantity of effluents generated (Info effluents), product's total life cycle cost (Info ACV), whether there are complaints against suppliers using child/slave labour or similar conditions (Info Denunciations), information about reported work accidents (Info Accidents) and complaints from the community about suppliers' premises (Info complaints). The significance level adopted is $p<0.05$, and data are computed by the Statistical Package for Social Sciences (SPSS) 18.

A comparison between the two groups shows there are no statistically significant differences for the Info_Energy (p=0,095), Info_ACV (p=0,066), Info_Denunciation (p=0,115) and, Info_Accidents (p=0,069) variables. As such, neither group shows significant differences regarding the frequency at which the enterprises look for information about the supplier in their selection process. However, enterprises that use certifications as a selection criterion show significantly higher frequencies of searches for information when selecting suppliers than do enterprises that do not use these certifications as a criterion.

Question 28 is designed to obtain information about socio-environmental criteria (such as compliance with labour laws, suppliers' social-environmental performance and compliance with environmental legislation) of supplier selection rather than traditional criteria (such as price, quality, delivery, terms of payment, localization, long run relationship). The interviewees classified the different dimensions from 1 (least important) to 10 (most important). Price, quality and labour law compliance showed the highest averages. The results show that the traditional criteria are still key, and labour law compliance is the only relevant social-environmental criterion because Brazilian labour law is very strict and business costs can increase significantly from fines and reputation loss if it is not met.

It was also applied the Spearman's rho test for non-parametric data (e.g., Low, Chapman, and Sloan (2007)) to analyse possible correlations among questions 18 to 27. Non-parametric statistics are used because the variables do not follow a normal distribution, as assessed by Kolmogorov-Smirnov's test ($p < 0,01$). The results are shown in Table 3. One of the highlights is the negative correlation between Info ACV and Info complaints (rho=0.59, p=0.029) and the positive correlation (rho=0.861, p=0.000) between Info residues and Info Effluents. The later shows the importance of internal control in avoiding the detrimental impacts of community complaints, which is more of an external and social concern, in terms of a product's total life cycle cost. Regarding positive correlations, the results

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

corroborate Hart (1995) and Sharma and Henriques (2005) who state that companies in the early phases of sustainability initiatives focus on pollution control and eco-efficiency. Eco-efficiency refers mainly to water conservation, use of energy and materials, and greater fuel efficiency.

Table 3 - Correlations between criterions to suppliers' selection

		Info energy	Info greenhouse	Info water	Info ozone	Info residues	Info effluents	Info ACV	Info labour	Info accidents	Info complains
Info energy	Corrd. coeff.	1,000	,691**	,635**	,545**	,515**	,455**	-,177	,277	,492**	,370*
	sig (2-tailed)		,000	,000	,000	,001	,005	,295	,096	,002	,024
	no	37	37	37	37	37	37	37	37	37	37
Info greenhouse	Corrd. coeff.		1,000	,640**	,812**	,642**	,635**	-,192	,458**	,415*	,314
	sig (2-tailed)			,000	,000	,000	,000	,254	,004	,011	,058
	no		37	37	37	37	37	37	37	37	37
Info water	Corrd. coeff.			1,000	,716**	,650**	,592**	-,142	,235	,310	,429**
	sig (2-tailed)				,000	,000	,000	,402	,161	,062	,008
	no			37	37	37	37	37	37	37	37
Info ozone	Corrd. coeff.				1,000	,750**	,719**	-,283	,396*	,346*	,402*
	sig (2-tailed)					,000	,000	,089	,015	,036	,014
	no				37	37	37	37	37	37	37
Info residues	Corrd. coeff.					1,000	,861**	-,135	,426**	,419**	,514**
	sig (2-tailed)						,000	,425	,009	,010	,001
	no					37	37	37	37	37	37
Info Effluents	Corrd. coeff.						1,000	-,161	,475**	,455**	,445**
	sig (2-tailed)							,341	,003	,005	,006
	no						37	37	37	37	37
Info ACV	Corrd. coeff.							1,000	-,238	-,270	-,359*
	sig (2-tailed)								,155	,105	,029
	no							37	37	37	37
Info labour	Corrd. coeff.								1,000	,505**	,491**
	sig (2-tailed)									,001	,002
	no								37	37	37
Info accidents	Corrd. coeff.									1,000	,707**
	sig (2-tailed)										,000
	no									37	37
Info complains	Corrd. coeff.										1,000
	sig (2-tailed)										
	no										37

Note: *Correlation is significant at the 0.05 level (2-tailed); **correlation is significant at the 0.01 level (2-tailed)

The results suggest that buying organizations present different degrees of maturity with regard to the introduction of social-environmental criteria in their supply chain management. Some organizations do not use any method at all, while others apply methods with different degrees of complexity to assess the social and environmental performance of their suppliers. Based on the theoretical background and empirical research it was developed a classification of the level of maturity of organizations considering social and environmental practices. The buying organizations are classified into four maturity levels ranging from 0 (zero) to 3 (three), based on the adjustment to social-environmental criteria (Figure 1).

Figure 1 - Maturity degree of organizations for social and environmental questions in the supply process

Use of traditional criteria (price, quality, delivery speed, reliability and flexibility	Use of listings to accredit and qualify supplier	Organizational direction to incorporate social and environmental questions. However, no materialization in actions along the supply process.	Social and environmental criteria used in the suppliers' selection and monitoring.
Level 0	Level 1	Level 2	Level 3
Objective	Compliance with legislation	Development of an organizational infrastructure	Development of systems able to identify criteria and corresponding impacts
Tools	"Dirty List" from Labour Ministry. IBAMA's List (companies that do not obey the Brazilian environmental law).	Establishment of policies, leadership commitment to social and environmental causes, training related to the issue and goal setting incorporating economic, social and environmental perspectives.	Commitment is materialized in supplier selection practices. Suppliers are evaluated and selected based on economic, social and environmental criteria. Metering of social and environmental criteria are already known and consolidated.

Source: Authors' compilation.

Level zero (0) corresponds to organizations that only consider traditional supplier selection criteria such as price, quality and quantity.

At level one (1), the companies are exclusively concerned with complying with the law. This is why the listings published by regulatory agencies (such as Brazilian Institute of Environment – IBAMA) are used to accredit and qualify suppliers. However, middle and upper management do nothing to insert social and environmental aspects into supply chain processes.

Level 2 organizations have a managerial direction, and buyers support infrastructure to aggregate social and environmental elements into the supplier selection process. Organizations at Level 2 are characterized by listings used to accredit and qualify suppliers. It is also possible to notice upper and middle management's incorporation of sustainability and social responsibility into the

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

supply process, enforcement of policies, leadership commitment to social and environmental causes, availability of training related to the issue, and goal setting incorporating economic, social and environmental perspectives.

Finally, organizations at Level 3 are those in which the organizational commitment is materialized through supplier selection practices. The suppliers are assessed and selected based on economic, social and environmental criteria. Social and environmental criteria metering methods are already well known and consolidated.

In terms of the managerial implications for reaching a higher maturity level, it is first mandatory for buyers to obtain more experience in sustainable procurement to successfully deliver sustainability requirements. Second, the Brazilian Chemical Industry Association (ABIQUIM) must emphasize the benefits of sustainable procurement to create a sustainable culture within the chemical industry. Similar to the findings of Ruparathna and Hewage (2015), sustainability requirements for the Brazilian chemical industry are often associated with extra costs, mainly those related to certification. Further, the implementation of sustainable purchasing requires action and participation by all stakeholders. In this research, procurement managers and analysts agree that sustainable procurement is an important initiative, a positive indication of the chemical industry's commitment to sustainable procurement.

6 Final considerations

This paper aims to investigate the adoption of sustainable procurement in the Brazilian chemical industry context. Questionnaires were sent to professionals from the Brazilian Chemical Industry Association (ABIQUIM) and from thirty-seven associated companies. The results provide inputs to elaborate empirical illustrations about sustainable procurement practices of Brazilian chemical companies. There are indications that companies continue to manage supplier selection processes in a traditional way, utilizing standard measures such as cost, quality, and delivery punctuality. There is often a mismatch between a focus on social-environmental issues and purchasing operations when economic and social criteria are taken into consideration.

There are indications that the main concern is the lack of full compliance with labour laws with respect to suppliers' selection criteria based on social-environmental legislation. The industry attaches more importance to traditional criteria, i.e., price and quality, than to social and environmental aspects. Labour laws play an important role in the chemical industry, and rising costs are attributed to brand reputation harm and the imposition of fines.

In line with Genovese, Koh, Bruno and Esposito (2013), this work highlights the difficulty associated with mapping social-environmental leadership in sustainable procurement operations in some the chemical industry. The results indicated that companies are at the second stage of maturity.

Actions related to social and environmental issues occur in policies and documents and are reflected through middle and upper management commitments. These findings are also consistent with Meehan and Bryde (2011), who present the case in which the development of policies is emphasized rather than the ensuring sustainable purchasing, thus evidencing the difficulty of integrating sustainability into the supply chain. Notwithstanding supplier selection, they argue that, in adopting social-environmental criteria, the procuring firm must be willing to promote and adopt these new social and environmental criteria. It is, however, a challenge to unfold the operations behind social-environmental strategy and establish specific and applicable indicators for the purchasing functions, as noted by Gimenez et al. (2012) and Sodhi (2015).

This work addresses some gaps in the current literature. The first refers to the consideration of both environmental and social criteria following the concept of the TBL. Second, this research addresses the importance of identifying and evaluating the criteria considered in supplier selection in line with Govindan et al. (2015).

The results offer new insights for exploring these issues for the same procurement firms in different institutional environments, for verifying the weight of labour laws and for ascertaining whether the weight of this criterion is really more important in some countries.

Regarding limitations, further research in this field may expand empirical investigation by considering quantitative research methods as surveys with different sectors. Comparative analyses of different countries could also explain the role of conjoined factors, such as economic conditions, regulations, culture, and leadership, in shaping the commitment of managers towards sustainability requirements in their supplier selection procedures.

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Artigos

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Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

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Appendix 1 - Sustainable Purchase Questionnaire

1. What type of supplies do you buy?* If you buy both, mark the most representative
   - Direct
   - Indirect
   - Others

2. Which of these titles fits you best?
   - Purchasing Director
   - Purchasing Manager
   - Purchasing Analyst

3. What size organization do you work for?*
   - Large
   - Medium
   - Small

4. The organization you work for considers social-environmental questions in their purchasing decisions.* Mark whether you agree / disagree with the above information
   - Agree
   - Disagree

5. Social-environmental questions will increasingly influence purchase decisions.* Mark whether you agree / disagree with the above information.
   - Agree
   - Disagree

6. The organization I work for is undertaking actions towards adding sustainability in purchasing. * Mark whether you agree / disagree with the above information.
   - Agree
   - Disagree

7. My organization has a written purchasing policy enhancing the sustainability commitment. *
   - Yes
   - No

8. Do you understand that the upper management support is vital to implement sustainable purchasing?*
   - Yes, management support is vital
   - No, management support is irrelevant

9. Do you see leadership commitment to address sustainability issues?*
   - Yes, my leadership is committed to sustainability
   - No, I do not see commitment from my management regarding sustainability

10. Did you attend any training related to sustainability development in your company?*
    - Yes, I was trained on sustainability
    - No, I was not trained on sustainability

11. Does the organization you work for have sustainability goals for the purchasing function?*
    - Yes, there are sustainability goals
    - No, I am not familiar with sustainability goals

12. Does the organization you work for have partners (NGO's) to incorporate social and environmental aspects to the purchasing function ?

o   Yes, there are partnerships with NGO's for social and environmental issues
o   No, I am not familiar with partnerships with NGO's for social and environmental issues

13. Do you believe you are prepared to include and assess social and environmental issues in your suppliers' selection?*
o   Yes, I know how to evaluate suppliers' social-environmental performance.
o   No, I am not familiar with how to evaluate suppliers' social-environmental performance

14. Do you feel the need of a prescriptive model on how to include social-environmental aspects for the selection of my supplier?*
o   Yes, a prescriptive model would help me incorporate social-environmental aspects in my suppliers' selection
o   I do not deem necessary to have a model to include social and environmental questions in my suppliers' selection.

15. Does the organization you work for impose social-environmental requirements to the suppliers that are stricter than the existing law?*
o   Yes, the social-environmental requirements are stricter than the legally required.
o   No, complying to law is enough
o   I do not know

16. The organization I work for supports suppliers' to improve their social-environmental performance.
o   Agree
o   Disagree

17. For the suppliers' selection I use certifications as a criterion (e.g.: ISO 14001)
o   Yes
o   No

18. For the suppliers' selection, I obtain information on the energy matrix and quantity used to produce the purchased good
o   Always
o   Most of the time
o   Seldom
o   Never

19. In the suppliers' selection, I obtain information on emissions causing the greenhouse effect?*
o   Always
o   Most of the time
o   Seldom
o   Never

20. For the suppliers´selection, do I obtain information on the quantity of water used to produce the supplied good?
o   Always
o   Most of the time
o   Seldom
o   Never

21. For the supplier´s selection, do I obtain information on the volume of the ozone layer harmful gases emission?
o   Always
o   Most of the time
o   Seldom
o   Never

22. For the supplier´s selection, do I obtain on the quantity of (harmful and non-harmful) wastes/residues generated?
o   Always
o   Most of the time
o   Seldom
o   Never

23. For the supplier's selection, do I obtain information on the quantity of generated effluents?
o   Always
o   Most of the time
o   Seldom
o   Never

24. For the supplier´s selection, do I obtain information on the total cost for product´s lifetime cycle?
o   1- Maintenance and supply disposal costs are always considered to select a supplier
o   2- Most of the times maintenance and supply disposal availability are considered to select supplier.
o   3- Few times or never, these are difficult information to obtain. As such, for the supplier's selection, I just consider the acquisition costs.

25. When selecting suppliers, I verify if there are complaints on supplier using child /slave labour or identical conditions checked
o   Always
o   Most of the time
o   Seldom
o   Never

26. When selecting suppliers, I obtain information on reported work accidents at the supplier
o   Always
o   Most of the time

Piao, R. S., Ide, M. S., Scur, G., Campos-Silva, W. L., & Khorana, S. (2020). Sustainable procurement practices in the Brazilian chemical industry context

Artigos

o Seldom										
o Never										
27. When selecting suppliers, I obtain information on complaints from the community about the suppliers' premises										
o Always										
o Most of the time										
o Seldom										
o Never										

28. Classify, from 1 to 10, by level of importance, the main suppliers' selection criteria *

	Least important									Most important
	1	2	3	4	5	6	7	8	9	10
Price	O	O	O	O	O	O	O	O	O	O
Quality	O	O	O	O	O	O	O	O	O	O
Comply to labour law	O	O	O	O	O	O	O	O	O	O
Payment Terms	O	O	O	O	O	O	O	O	O	O
Suppliers' Social-environmental performance	O	O	O	O	O	O	O	O	O	O
Abide to environmental legislation	O	O	O	O	O	O	O	O	O	O
Delivery speed	O	O	O	O	O	O	O	O	O	O
Long-time relationship	O	O	O	O	O	O	O	O	O	O
Geographic location	O	O	O	O	O	O	O	O	O	O