Materiality Analysis in Aerospace Sustainable Supply Chains

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Abstract

Nowadays, following the increasing demand for air transportation, the commercial aviation sector is becoming the main driver of the global aerospace manufacturing industry. Also, sustainability has emerged as a growing concern globally and specifically for the industry. Sustainable supply chain management appears as a key factor for the aerospace industry development. Sustainability has become a growing concern for companies and stakeholders with companies starting to account for sustainability issues in their reports and management.

When discussing sustainability performance, the question on the materiality of the different indicators naturally arises. The correct approach to the relevant aspects of sustainability can become critical for the organization's successful results on sustainability. Research has been done regarding the materiality on sustainability and development of frameworks for sustainability reporting. However, both the literature and the industry are lacking a uniform comprehensive approach to this subject

The present article starts by contextualising the aerospace industry and the commercial aviation sector, followed by the characterisation of the problem to be studied. A comprehensive state of the art literature review is then conducted, focusing on the relevant themes to support the development of a materiality assessment methodology in the context of sustainability. Then, the proposed methodology is tested and the results discussed and compared with existing comparable data. Finally, a case study on Embraer is developed focusing on the material issues the company has identified in its sustainability strategy.

Keywords: sustainability, aerospace supply chain, key performance indicators, materiality

1. Introduction

Following the increasing demand for air transportation, the commercial aviation sector is nowadays becoming the main driver of the global aerospace manufacturing industry. However, in the last decade, the industry has been dealing with several challenges, from terrorism and natural disasters to global economic instability and record fuel prices. The financial and environmental challenges are nowadays driving fuel efficiency and cost reduction innovations, as well as trying to end monopolies through the supply chain and developing strategies to cut the industry's carbon footprint. Collaboration between stakeholders across the industry is now the vision for the future, and it is believed to be the path for sustainability (IATA 2016).

Today, sustainability is a top concern for most organizations. Managers are now required to concern about the economic, ecological and social pillars of sustainability of the business (Carter & Rogers 2008). In industrial and manufacturing businesses, the sustainability of supply chain (SC) has a major impact on the organizations' performance (Ansari & Kant 2016). The aerospace manufacturing industry

is no exception, and all its complexity makes the supply chain impact in sustainability even more relevant.

When discussing sustainability performance, the question on the materiality of the different indicators naturally arises. The correct approach to the relevant aspects of sustainability can become critical for the organization's successful results on sustainability (Khan et al 2016).

Several articles and frameworks have been developed regarding the materiality on sustainability and development of frameworks for sustainability reporting. However, both the literature and the industry are lacking a uniform comprehensive approach to this subject (Lydenberg et al 2010).

Starting by characterizing the aerospace industry and reviewing the state of the art on the themes above, this article comes as a proposal for a comprehensive framework for defining and assessing materiality in the context of the aerospace supply chain sustainability.

1.1 Contextualisation

Nowadays, following the increasing demand for air transportation, the commercial aviation sector is becoming the main driver of the global aerospace manufacturing industry. The typical aerospace supply chain currently follows a systems integrator model, where Original Equipment Manufacturers (OEM) design, develop, assemble and sell aircrafts. Tier-1 suppliers are now expected to design, develop and manufacture major modules and assemblies. However, as capable suppliers are yet not commonly available, the biggest players in the industry tend to use all available capacity. The supply chain is also characterized by high OEM control through the whole chain, and by increasing collaboration.

Sustainable supply chain management appears as a key factor for the aerospace development. Sustainability has become a growing concern for companies and stakeholders with companies starting to account for sustainability issues in their reports and management. When it comes to materiality, on their 2013 report, "Sustainability's Next Frontier", Massachusetts Institute of Technology's Sloan Management Review (MIT SMR) and The Boston Consulting Group (BCG) offer evidence that 52% of companies that mostly or completely address their material sustainability issues also profit from their sustainability strategies. In contrast, only 16% of companies that pay little or no attention to material issues report that they profit from sustainability (Kiron et al. 2017). Although some sustainability concerns are common within a given industry, material sustainability issues vary by industry. Other authors have come to similar conclusions. Khan et al (2016) reported results that indicate that firms with strong ratings on material sustainability topics outperform firms with poor ratings on these topics. In contrast, firms with strong ratings on immaterial sustainability topics do not outperform firms with poor ratings on the same topics.

Two research questions were derived for this article, regarding materiality in the aerospace supply chain sustainability: (RQ1) "Which methodology can be used to assess materiality in the sustainability strategy in the aerospace supply chain?"; (RQ2) "What are the material aspects in the sustainability strategy in the aerospace supply chain?"

This article aims to organize a comprehensive state of the art followed by the development of a materiality definition in the context of sustainability and a methodology to assess it, followed by the application of the proposed methodology and comparison of the obtained results with existing comparable data. The work will end with a case study on Embraer focusing on the material issues the company has identified in its sustainability strategy. This article is part of a bigger project: IAMAT – Introduction of advanced materials technologies into new product development for the mobility industries. The main goal of the project is to develop an integrated framework for product development evaluation that can exploit the potential use of advanced materials, manufacturing technologies and structures in the aeronautical industry.

1.2 State of the art

The scientific community is deeply committed to investigate sustainability and sustainable development issues due to the growing importance of these matters in business practices and the lack of consensus on what is the best approach to apply. The World Business Council for Sustainable Development (WBCSD) was founded with the aim to "galvanize the global business community to create a sustainable future for business, society and the environment" (WBCSD, 2012). These three elements were effectively attached and linked together to form the most generalised model of sustainable development: The Triple Bottom Line.

John Elkington introduced The Triple Bottom Line (3BL) concept in 1994 (Elkington, 2004): *"Triple Bottom Line accounting attempts to describe the social and environmental impact of an organization's activities, in a measurable way, to its economic performance in order to show improvement or to make evaluation more in-depth"* (Elkington, 1998). The economic dimension of sustainability concerns the organisation's impacts on the economic conditions of its stakeholders and on the economic systems at local, national, and global levels (Global Reporting Initiative, 2011). The environmental dimension of sustainability concerns an organization's impacts on living and non-living natural systems, including ecosystems, land, air, and water (Global Reporting Initiative, 2011). *"Social sustainability is a quality of societies. It signifies the nature-society relationships, mediated by work, as well as relationships within the society. Social sustainability is given, if work within a society and the related institutional arrangements: 1) satisfy an extended set of human needs; 2) are shaped in a way that nature and its reproductive capabilities are preserved over a long period of time and the normative claims of social justice, human dignity and participation are fulfilled" (*Littig and Griessler, 2005).

As to materiality in the context of sustainability, a state-of-the-art revision was conducted on materiality on sustainability issues, arguing for its significance, and multiple approaches to assess materiality were presented, according to the most recent market practices. In terms of definition, materiality is frequently a legal concept as well because some countries, by either statute, case law or regulation, have established a definition of materiality they require to be applied in their jurisdiction. In financial reporting, materiality is commonly thought of as a threshold for influencing the economic decisions of those using an organization's financial statements, investors in particular. A similar concept is also important in sustainability reporting. The Global Reporting Initiative (GRI) defines materiality as a principle for a company's reporting to 'cover topics that reflect the organization's significant economic, environmental and social impacts or substantively influence the assessments and decisions of stakeholders' (GRI 2016). The International Integrated Reporting Council (IIRC), in its International <IR> Framework (2013), defines materiality as a principle guiding an organization's reporting so that 'an integrated report should disclose information about matters that substantively affect the organization's ability to create value over the short, medium and long term'. The Sustainability Accounting Standards Board (SASB) uses the definition by the United States laws regarding companies' reporting saying that 'materiality recognizes that some information is important to investors in making investment and voting decisions, while other information is not' (SASB 2017). SASB uses this definition to guide their process on assessing the environmental, social and governance topics that are reasonably likely to have material impacts on the financial condition or operating performance of companies in a given industry.

There are several frameworks already developed to assess materiality, most of them leaving for the organizations the decision process on materiality assessment. While the IIRC gives a broader view on the materiality subject, the GRI and the SASB frameworks are more focused on sustainability. They all underline the importance of gathering information from the different stakeholders that have a relationship to the reporting organization and also the importance of prioritizing topics. Some of them have already

gathered information from different stakeholders, in different industries, creating databases on the material issues facing sustainability strategies. The SASB's Materiality Map is one of them and is the one the currently offers more insight.

Lydenberg et al. (2010) propose a method for identifying key performance indicators (KPIs) on the sustainability impacts of corporations in specific industries. This method proposed by the authors builds on a broad disclosure framework such as that of the GRI and it suggests how those sustainability KPIs most material to all stakeholders can be identified. It consists of a six-step approach for identifying specific indicators by industry sector.

2. Methodology

A methodology for assessing the materiality of the different sustainability indicators will be proposed building on the conclusions reached so far and on the methodology followed by Lydenberg et al. (2010). It is presented on Figure 1 below.

Figure 1 – Proposed methodology

2.1 Pool the issues

In this step the pool of issues needs to be defined. The pool of issues represents a broad universe of sustainability risks or opportunities that could apply to the industry. In the context of this article, the issues identified in Abreu (2017) will be used as the pool of issues because Abreu (2017) has conducted a survey for many aerospace industry stakeholders and was able to first identify the relevant stakeholders and then review their engagement towards sustainability.

2.2 Apply Materiality Test

An adapted version of the Materiality Test envisioned by Lydenberg et al. (2010) will be employed. A score for each issue will be given on a four-point (0-3) Likert scale using each of the same five materiality categories used by the authors: Financial impacts/risks, Legal Regulatory Policy Drivers, Business Peer-based Norms, Stakeholder Concerns/Social Trends and Opportunity for Innovation. The issue will be scored in each of these five categories and then the scores are added together to give an overall score of 0-15, with the higher scoring issues understood to be more material. This method relies on subjective judgments for each category of analysis and it is important to note that the numbers generated through this process rely on judgment. To have a robust assessment, the approach in this article to apply the materiality test was to set up a Focus Group of specialists.

2.3 Identify the material issues

The pool of issues will be ranked to identify the materiality according to the results obtained from the Focus Group. Once the materiality tests have been applied to the broad set of sustainability issues and those issues ranked by their relative importance within a particular industry, a determination needs to be made as to where to draw the line in establishing material issues according to the results obtained from the Materiality Test.

2.4 Compare with existing comparable data

The obtained results from the previous steps will be compared with existing data previously identified in this article. The goal is to understand if the proposed methodology yields similar results, validating its robustness and applicability.

2.5 Embraer case study

The materiality issues will be compared to Embraer's sustainability strategy, serving as a case study to highlight the practical applicability of this work. Embraer has been selected as case study because it is a subject of the IAMAT project and is a good example of a manufacturing company in the sector that has already established their key sustainability issues to tackle.

3. Results

In this section the data obtained with the application of the proposed methodology is presented and the results discussed. The section starts with the results of the Focus Group of specialists. The group gathered to go through all the 45 topics of the pool of issues and give a score to each one of them for each of the 5 categories. The participants were: the author of this article as the facilitator, a specialist on the aerospace industry, a specialist on the aerospace supply chain and two specialists on both sustainability and supply chain.

From the classification proposed by the group the most material aspects can be identified. The results were analysed in further detail and a cut-off point was defined for selecting the most relevant aspects. For this particular case, the cut-off point was not clear as it would be expected from the literature. In order to have a better understanding of the data dispersion, some statistics calculations were made about the data in hands (minimum, maximum, mean, median, standard deviation, coefficient of variation and first and third quartiles). For the purposes of this article, the 3rd quartile will be used as it defines a cut-off point based on the dispersion of the data and it allows for the inclusion of a relevant number (13) of aspects to be considered in the next sections. At this stage, a conclusion is reached that the cut-off point should also have been included in the Focus Group to benefit from the expertise of the participants. It is also not possible to rely on the ranking of the issues as many have tied scores. Further analysis – perhaps using multiple-criteria analysis – can be taken as future work.

The complete analysis resulted in the identification of thirteen most material sustainability aspects in the context of the aerospace industry: (1) Emissions, (2) Products and Services, (3) Training and Education, (4) Materials, (5) Energy, (6) Occupational Health and Safety, (7) Security practices, (8) Anti-corruption, (9) Procurement practices, (10) Employment, (11) Compliance (Social pillar: Society), (12) Customer Health and Safety and (13) Compliance (Social pillar: Product Responsibility). The expected prominence of Environmental issues was confirmed and there were interesting results with the Social pillar. Only one economic topic reached the thirteen aspects. Table 1 below details the results from the focus group for the thirteen aspects.

Table 1 – Identified material issues with the respective results from the focus group

Aspect	Pillar	Financial	Legal/Regulatory/Policy	Industry	Stakeholders	Innovation	SUM

Emissions	Environmental	3	3	3	3	3	**15**
Products and Services	Environmental	3	3	3	3	3	**15**
Training and Education	Social	3	3	3	3	3	**15**
Materials	Environmental	3	3	3	2	3	**14**
Energy	Environmental	3	2	3	3	3	**14**
Occupational Health and Safety	Social	3	3	3	3	2	**14**
Security Practices	Social	3	3	3	3	2	**14**
Anti-corruption	Social	3	3	3	3	2	**14**
Procurement Practices	Economic	3	3	3	1	3	**13**
Employment	Social	3	3	3	3	1	**13**
Compliance	Social	2	3	3	3	2	**13**
Customer Health and Safety	Social	3	3	3	2	2	**13**
Compliance	Social	2	3	3	3	2	**13**

The obtained results are then going to be compared to the results from existing comparable data. The goal is to understand if the results match i.e. if the indicators that resulted from the proposed methodology are in line with the indicators included in the existing data.

The SASB Materiality Map will be used. It is important to note that there is no order for the presented indicators. The Map presents a set of indicators with a white, light-grey or dark-grey colour as to identify the relevance of the indicator. For the comparison of the material sustainability issues resulting from the proposed methodology and the ones identified by SASB, the following industries will be analysed: Aerospace & Defense (Resource Transformation sector), Airlines (Transportation sector) and Air Freight & Logistics (Transportation sector). The topics from the Materiality Map ('likely a material issues for companies in the industry) for the three above identified industries are included in Table 2 below alongside the results from this work.

Table 2 – Comparative analysis of the found issues and SASB's Materiality Map

SASB A&D	SASB Airlines	SASB Air Freight & Logistics	Proposed methodology
Energy Management	GHG Emissions	GHG Emissions	Emissions
Waste & Hazardous Materials Management	Labour Practices	Air Quality	Products and Services
Data Security	Competitive behaviour	Labour Practices	Training and Education
Product Quality & Safety	Critical Incident Risk Management	Employee Health & Safety	Materials
Product Design & Lifecycle Management		Supply Chain Management	Energy

Materials Sourcing & Efficiency		Critical Incident Risk Management	Occupational Health and Safety
Business Ethics			Security practices
			Anti-corruption
			Procurement practices
			Employment
			Compliance (Social pillar: Society)
			Customer Health and Safety
			Compliance (Social pillar: Product Responsibility)

When comparing the 4 sets of date, the first conclusion that can be drawn is that, for each of the sectors, SASB only highlights a small number of issues. Since our proposed methodology is more comprehensive (the scope is larger), in a first approach it can be concluded that a bigger number of issues is required. But the difficulty in establishing the cut-off point and the tied scores could also explain the high number of topics. For future work a more focused analysis (e.g. on the different subsectors of the aerospace industry) is recommended.

It is also interesting to note that, looking only to the three sets from SASB, there are differences in the reported topics. For the Aerospace & Defense sector there seems to be a prominence of topics related to the manufacturing process and is the only sector where Business Ethics appears – once again, that does not happen in the other two sectors. That can also explain the difficulty found in the proposed methodology since the subject was too wide and not targeted to a specific part of the supply chain.

It is also interesting to note that the Labour practices are also highlighted by SASB for the Airlines and Air Freight and Logistics. Also 'Employee Health & Safety' is highlighted for the Air Freight and Logistics subsector, confirming the results obtained in the proposed methodology.

Finally, the case study of Embraer is studied. Embraer states Sustainable management as one of its 'strategic objectives', recognizing that it is fundamental for the continuity of any business and to align economic goals with socio-environmental awareness – this can be seen as a practical application of the Triple Bottom Line, the reference for sustainability throughout this article. The company has established a Sustainability Committee that works with stakeholders and company leaders to develop strategies of sustainability, using as guide the Sustainable Development Objectives as defined by the United Nations (UN) as well as sustainability questionnaires outlining good practices. Following on from this work, the company defines indicators and targets, which are integrated into their sustainability plan (Embraer 2019).

The eight material subjects are presented in the image in Figure 21, with an indication of their criticality (measured by score) for the Embraer strategy and the stakeholders.

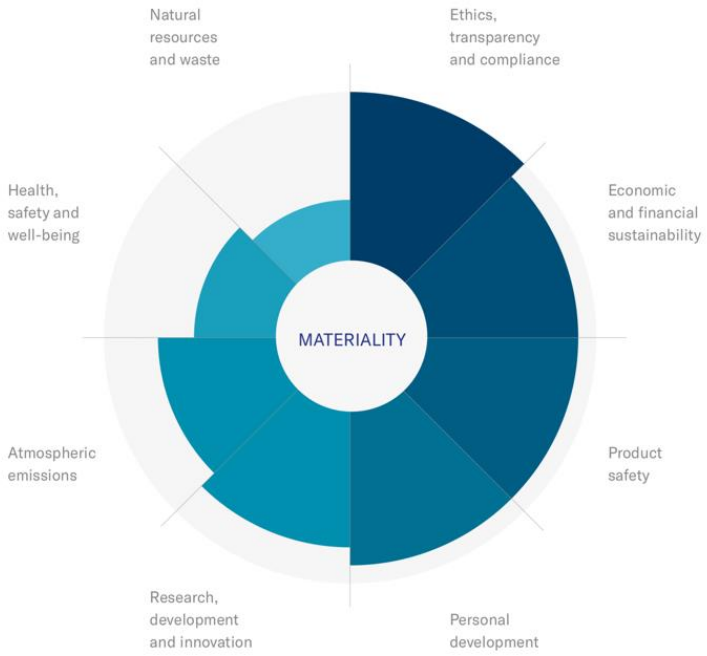

Figura 2 – Embraer Materiality Matrix – Annual Report 2018 (Embraer 2019)

This Materiality Matrix has eight broad categories: Ethics, transparency and compliance; Economic and financial sustainability; Product safety; Personal development; Research, development and innovation; Atmospheric emissions; Health, safety and well-being; Natural resources and waste.

As part of step 5 of the proposed methodology, the obtained results will be compared with the eight identified goals from Embraer. In Table 3 a side-by-side summary of both is presented to help drawing conclusions:

Table 3 – Comparative analysis of the found issues and Embraer's sustainability goals

Embraer	Our proposed methodology
Ethics, transparency and compliance	Emissions
Economic and financial sustainability	Products and Services
Product safety	Training and Education
Personal development	Materials
Research, development and innovation	Energy
Atmospheric emissions	Occupational Health and Safety
Health, safety and wellbeing	Security practices
Natural resources and waste	Anti-corruption
	Procurement practices
	Employment
	Compliance (Social pillar: Society)
	Customer Health and Safety
	Compliance (Social pillar: Product Responsibility)

The first conclusion that can be drawn is, once again, that there are only eight topics covered by Embraer and thirteen out of forty-five have been identified with the proposed methodology. In the case of Embraer, the issues identified are more generic and each one encompasses a wide variety of targets as seen in their Sustainability Plan for 2020. For instances, the 'Natural resources and waste' topic covers five concrete goals encompassing certification for the factories and targets for water, energy (electricity), hazardous waste and non-hazardous waste. In this regards, Embraer's strategy seems to be more developed.

The atmospheric emissions issue confirms, once again, that this is a major topic for the commercial aviation sector and is transversely referred throughout this article. Also the topic of energy is a constant as can be seen in both the results from the proposed methodology and the target indicator for the 'Natural resources and waste' pillar in Embraer's strategy.

Overall, a suggestion to Embraer could be made to include a bigger focus on Training and Education for its employees. Although they have already established a goal for people development, it is currently only focused on diversity and inclusion. This is something that feeds back into the objectives of continued sustainability engagement and also the need for innovation required by the industry, as seen in previous chapters and confirmed by Embraer's pillar of 'Research, development and innovation'.

There is the case of the 'Ethics, transparency and compliance' pillar that only includes a target regarding employees responding to an ethics survey. Since this is the subject with the highest score for Embraer, some more work should be developed into this. The Compliance aspects identified in the thirteen material topics (both in the Social pillar – the first related to Society and the second related to Product Responsibility) can be included in Embraer's strategy. Both these aspects can strengthen Embraer's standing on compliance and also transparency. It can also help to steer the company into more focus complying with the regulations, which is something that can be valued by all stakeholders.

4. Conclusions

A proposed methodology was outlined to assess the materiality of the different sustainability indicators. The proposed methodology has been applied with the execution of a focus group with the goal to come up with a set of issues considered material for the sustainability strategies in the aerospace industry. The complete analysis resulted in the identification of thirteen most material sustainability in the context of the aerospace industry: (1) Emissions, (2) Products and Services, (3) Training and Education, (4) Materials, (5) Energy, (6) Occupational Health and Safety, (7) Security practices, (8) Anti-corruption, (9) Procurement practices, (10) Employment, (11) Compliance (Social pillar: Society), (12) Customer Health and Safety and (13) Compliance (Social pillar: Product Responsibility). The matter of the cut-off point was of great importance and the difficulties in establishing it indicate that more focus in needed. The cut-off point discussion could have been included in the Focus Group to obtain a more sustained result with the expertise of the participants in the Focus Group.

As to the objectives of this article, summarized in the two research questions, the proposed methodology offers a good framework depending ultimately on judgement. The methodology presents a good option for its transparency and applicability provided that the criteria are well defined and the scope is more developed. As to the second research question, it is concluded that it is not possible to give a definitive answer on the material sustainability indicators in the aerospace supply chain as a whole as the literature and results demonstrate. Some topics (as Emissions) are a constant but it is hard to clearly state a number of issues deemed material for a sustainability strategy for all the supply chain.

As future work, a definition of materiality in the context of sustainability should be determined and adopted throughout the industry and a common general framework for assessing it should be defined. From that moment onwards, each organization should have the power to define its topics, even

if there is a common basis for its industry. It is also recommended to test the proposed methodology with a more detailed focus on particular segments of the aerospace industry in general or the commercial aviation sector in specific. It would also be interesting to test this proposed methodology for materiality assessment in the context of sustainability to other industries to prove the effectiveness of the model. The next step should be defining the relevant key performance indicators for each sustainability topics so that there is a reference/benchmark. Above all, the future work done in this field should be focused on developing a standardized approach to sustainability, combining efforts among all the relevant stakeholders so that a unified approach to sustainability can be reached.

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