Department of Engineering and Management

Sustainability assessment of the aerospace supply chain: stakeholders' engagement towards sustainability

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Extended Abstract
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A B S T R A C T

Managing the relations between the organization's stakeholders is one of the most important tasks during strategy making. Nowadays, aerospace manufacturers tend to be integrators of parts, systems and major modules produced by a supply chain with increasing complexity, which must be managed accordingly and in a sustainable way. The efficient management of sustainable supply chain requires decision support tools which can assess sustainability, in an integrated view of the triple bottom line (3BL) approach.

The increasing complexity of the industry's supply chain and the urgency for correctly managing stakeholders leads to the problem of evaluating the stakeholder's engagement towards sustainability. A complete stakeholders' analysis and performance assessment is therefore needed, working as an integrated decision support tool for the sustainable supply chain management.

The present work starts by contextualising the aerospace manufacturing industry and the commercial aviation sector, followed by the characterisation of the problem to be studied. A state of the art literature review is then conducted, focusing on relevant themes to support the development of a new stakeholders' analysis methodology that allows the identification of the most relevant stakeholders for the problem in study. Additionally, the stakeholders' engagement towards sustainability is studied and a sustainability performance assessment framework is suggested as an indicator of the stakeholders' engagement.

Keywords: sustainability, stakeholders' analysis, stakeholders' engagement, performance indicators, aerospace supply chain

1. Introduction

Nowadays, sustainability is a top concern for most organizations and managers are now required to concern about the economical, 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 organisations' 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 supply chain sustainability, the question on the relevancy of stakeholder engagement naturally rises. The management of stakeholders can then become critical for the sustainability across the SC and, consequently, for the organisation's sustainability (Bernhart & Maher 2011).

Several studies about stakeholders' analysis and sustainability performance measurement have been conducted during the past years. However, both the literature and the industry are lacking a tool which integrates these analyses and provides support for management decisions about stakeholder engagement towards sustainability in the aerospace supply chain.

Starting by characterising the aerospace industry, and reviewing the state of the art on the themes above, this dissertation comes as the development of a new methodology to address the stakeholders' analysis and sustainability performance measurement, in the context of the aerospace supply chain sustainability.

1.1. Contextualisation

Following the tradition across manufacturing industries, several supply chain models have been applied in aerospace manufacturing though the years. The evolution of the industry's supply chains shows the global trend to apply models based in globalisation and risk-sharing partnerships, evolving from joint ventures, stating that OEM-dominated supply chains are becoming obsolete (Rose-Anderssen et al. 2009). Nowadays, the general aerospace manufacturing supply chain is described as having the OEM as the focal company, with 4

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tiers of suppliers upstream and operator downstream, as shown in Fig. 1.

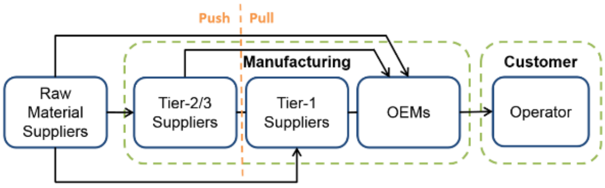

Fig. 1. General aerospace supply chain. (Adapted from Beelaerts van Blokland et al. 2010)

The supply chain sustainability has been considered as one of the key-themes to achieve corporate sustainability in aerospace manufacturing. Nowadays, companies seek to develop strategies to increase their corporate sustainability, starting by ensuring sustainability across the entire supply chain. However, this is not an easy task as the engagement of all entities is a major requirement, and their management can prove to be an extremely complex task. The following research questions arise when discussing the engagement of stakeholders towards sustainability in the aerospace manufacturing supply chain: (RQ1) "Who are the relevant stakeholders to supply chain sustainability?"; (RQ2) "How engaged are the relevant stakeholders and how can this engagement be improved?".

This dissertation aims to conduct a state of the art, followed by the development of a methodology for stakeholders' analysis and measurement of stakeholder engagement, so that research questions can be answered. A new multimethodology which allows the identification of the most relevant stakeholders, evaluating their engagement towards sustainability will also be developed, and a set of indicators to assess their sustainability performance and their engagement will be suggested.

1.2. State of the Art

The concept of *stakeholder* was defined by Freeman (1984) in some of the earliest work on stakeholders, as "any group or individual who can affect, or is affected by, the achievement of a corporation's purpose". During the years, broader and narrower definitions have been presented in stakeholder literature. The first as an attempt to demonstrate the reality that virtually anyone can be affected by an organization's actions; and the latest to face the reality that managers simply cannot attend to all potential or actual claims, and have to prioritise some over the others (Mitchell et al. 1997; Reed et al. 2009). The need for decision makers to understand who is affected by the decisions and actions they take, and who has the power to influence their outcome is becoming increasingly recognized as a critical management tool (Reed et al. 2009). In other words, managing the several and often competing demands and relationships between an organization's different stakeholders is considered one of the most important tasks during strategy making (Ackermann & Eden 2011).

The growing realisation that stakeholders could influence the decision-making process of an organization led to the natural development of approaches for stakeholders analysis (Brugha & Varvasovsky 2000). According to Reed et al. (2009), stakeholder's analysis can be characterised as a process that: (1) Defines the issue which will be affected by an action or decision; (2) Identifies the individuals, groups or organizations (i.e. stakeholders) who are affected by or can affect those actions or decisions; (3) Prioritises the stakeholders for involvement in the decision-making process.

Several methodologies have been proposed to approach the stakeholders' analysis during the years. Between the several stakeholders' identification methodologies, we highlight the following: the List evaluation stakeholders presented by Bryson et al. (2011), in which an individual or a small group brainstorms to reveal a broad list of potential stakeholders; the Snowball Sampling, as described by Reed et al. (2009), where an initial group of stakeholders identifies other stakeholders and provide their contacts, and by repeat the process more and more stakeholders are identified.

To differentiate stakeholders, we highlight the following methodologies: the Power-interest grid (Ackermann & Eden 2011), where stakeholders are placed in a matrix and classified as players, subjects, context steers or crowd; the Power, Urgency and Legitimacy diagram, presented by Mitchell et al. (1997), in which a Venn diagram is used to classify stakeholders as dormant, discretionary, demanding, dominant, dangerous, dependent or definitive stakeholders; the Support versus Opposition Grid, where stakeholders are classified as problematic, antagonistic, low priority or advocates (Nutt & Backoff 1987) or as weak opponents, strong opponents, weak supporters and strong supporters (Bryson et al. 2011).

At last, we highlight the following methodologies used for investigating relations between stakeholders: the Participation Planning Matrix (Bryson et al. 2011), in which stakeholders are placed in the columns and tasks in the rows of a matrix and the level of participation of each stakeholder in each task is specified; the Value Flow Mapping (Cameron et al. 2008), which identifies and represents complex relationships between stakeholders' categories, based on their added value to the problem.

After a complete stakeholders' analysis, composed by methodologies like the ones presented before, there is the need to measure the stakeholders' performance to solve the given issue. Indicators are quantitative or qualitative measures used to interpret the complex world around us, in such a way that makes it easily understood, when a direct measurement is not possible for financial or technical reason. The use of indicators in business management is tightly related to the need of tracking the organisation's progress in a measurable way as a tool to help the decision-making process and achieve success. Popova & Sharpanskykh (2010) defines these indicators as *Performance Indicators*. The definition by Parmenter (2015) goes further, presenting the performance indicators as well established measures of business performance which allow managers to identify problems and to directly act to significantly increase performance. However, Parmenter (2015) alerts to the fact that many companies have been using these measures in the wrong way. Unfortunately, performance indicators often fail to represent performance, but instead highlight problems of performance measurement.

The indicator validation process usually comes to the validation of indicators proprieties (Roubtsova & Michell 2013). By critically evaluating and testing each propriety, performance indicators can be considered effective or ineffective. As an example, Kueng (2000) presents six proprieties of performance indicators: quantifiability, sensitivity, linearity, reliability, efficiency and improvement-oriented.

2. Methodology

2.1. Stakeholders' Analysis

The Stakeholders' Analysis methodology used in this dissertation is mainly inspired in the work presented by Reed et al. (2009). However, the methodology for Stakeholders' Analysis to be used in this dissertation, is significantly different and follows a novel approach, presenting an integrated multimethodology for a complete analysis. This approach is based in the suggestions by Mingers & Gill (1997), who described the benefits of using more than one methodology in management sciences. The proposed multimethodology comprehends the application of three tasks (A, B, and C) and six steps (1 to 6). The multimethodology for the Stakeholders' Analysis is represented in Fig. 2.

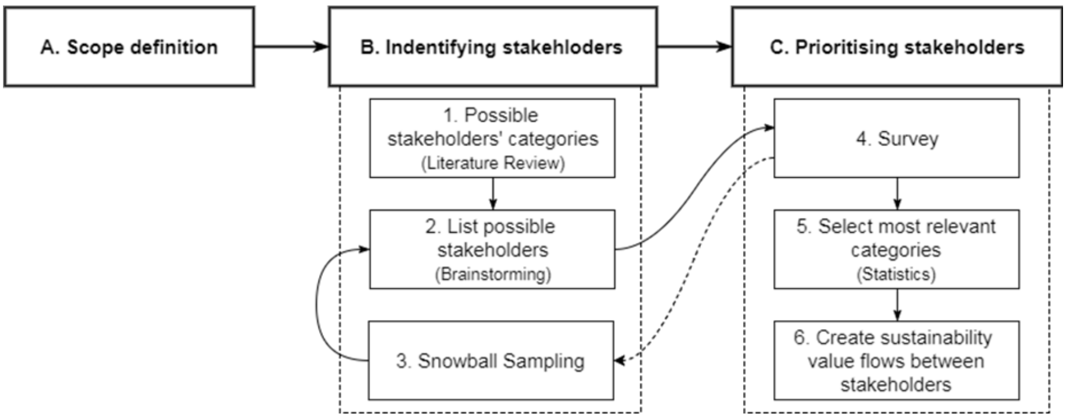

Fig. 2. Methodology for the stakeholders' analysis

The following sections describe in detail the methodologies that were used during the development of the dissertation, which originated this novel multimethodology approach to the stakeholders' analysis.

The objective of task A is to define the scope of the study by clearly defining its boundaries. The boundaries are established by defining the industry/sector, the context/stage and the main subject. In this case, the scope of the stakeholders' analysis is defined by the boundaries presented in Table 1.

Table 1
Scope definition

Industry/Sector	Context/Stage	Main Subject
Aerospace Industry/ Commercial Aviation	Sustainable supply chains	Identifying relevant stakeholders and their engagement

Task B consists on the identification of the stakeholders. It comes as a variation of the List evaluation stakeholders method, as presented by Bryson et al. (2011), where the brainstorming is supported by a previous literature review and definition of stakeholders' categories (e.g. suppliers, customers, etc.). The first and second steps of this task consisted in building a list of stakeholders' categories based in a literature review, and use that list as the starting point of a brainstorm to identify individual stakeholders. The third in this task was the application of the snowball sampling method, using approach presented by Reed et al. (2009).

The objective of task C is to prioritise stakeholders regarding their relevance to the sustainability of the supply chain and map their relations. This step is divided into three steps: survey; selecting most relevant categories; creating sustainability value flows between stakeholders. The survey was designed to be answered by the possible stakeholders, previously identified in step 2 and later identified in step 3. Therefore, it considers a stakeholder-led evaluation. Respondents were asked to evaluate themselves or their organisations regarding the attributes Power, Interest, Urgency, Legitimacy and Support towards the problem in study. By preforming a statistical analysis on the data from the survey, the most relevant stakeholder categories for the issue in study are selected with the application of this step. To facilitate the analysis by spreading the scores along the complete evaluation scale, a normalisation of the scores is performed by applying a linear interpolation equation. Then, there is the need to create an aggregated score for each stakeholder category, so that the most relevant ones are identified. Based on the fact that attributes do not hold the same importance regarding the problem, there is the need to weight each of their contributions to the final score: the numerical elicitation technique Swing Weighting (Goodwin & Wright 2014) was considered more adequate in the context of this analysis. The last step of the Stakeholders′ Analysis was based on the Value Flow Mapping methodology presented by Cameron et al. (2008), coming as the integration of the stakeholders′ engagement concept in the analysis. For each one of the most relevant stakeholders' categories, the inputs and outputs required to add sustainable value to the problem are brainstormed by a small group of experts, taking into consideration the inputs and outputs from the other categories. These sustainable value inputs and outputs must consider the economic, the environmental and the social nature of sustainability, following a 3BL approach. Then, stakeholders' categories are connected using the previously identified inputs and outputs, resulting in a flow map, which provides the visual conceptualisation of the ideal stakeholders' engagement towards sustainability.

2.2. Sustainability Performance: Measuring Stakeholders' Engagement

Following the stakeholders' analysis and the definition of the most relevant stakeholders' categories for the supply chain sustainability problem, the stakeholders' performance regarding sustainability must be assessed applying sustainability indicators. One of the crucial activities for the stakeholders' engagement towards sustainability is the sustainability reporting, which demonstrate interest and transparency regarding the subject. This practices help organisations in general to set objectives, measure performance and manage change in order to become more sustainable (GRI 2015). The sustainability assessment presented here is based in a qualitative analysis of the information reported by a sample of stakeholders of the aerospace supply chain. Only stakeholders from the most relevant categories are considered in this assessment.

3. Results

3.1 Stakeholders′ analysis

Considering the problem to be studied and the methodology to follow in the data acquisition, 14 stakeholders′ categories were chosen to be applied in the study: (1) Management Board (of the OEMs); (2) Customers; (3) Suppliers; (4) Services providers; (5) NGOs; (6) Scientific Community; (7) Employees; (8) Investors and Financial Institutions; (9) Media; (10) Consumers; (11) Shareholders; (12) Governments; (13) Local Communities; (14) Regulators.

Based on this list, the group of experts, which in this case was composed by three academics from IST and one from the MIT, brainstormed possible stakeholders (i.e. companies, organisations, groups, individuals) and listed 397 contacts. These contacts were then invited to participate in the survey.

A total of 36 answers were received. This represents a total response rate of 9,1%. However, 5 respondents did not complete the survey and, therefore, their answers were manually removed and were not analysed further. A total of 31 surveys were competed, which represents an effective response rate of 7,8%. The results presented next consider the data collected from the 31 completed surveys.

The sample was characterised using several criteria: function of the respondent with the organisation; direct work on sustainability; dimension of the represented organisations; stakeholders′ category of the respondent.

Most respondents hold an Employee function within their organisations (25,8%) or answered as Individuals not representing any organisation (25,8%). Most respondents do not work directly with the theme of sustainability, accounting for 61,3% of the sample. However, those who do work directly with sustainability represent a relevant 38,7% of the sample. Most respondents were not representing any organisation and answered as individuals. However, when excluding those, the sample is mainly composed by small organisations, with 1 to 250 employees (36,4%), followed by major organisations with more than 5000 employees (27,3%). The most represented stakeholders′ categories in the sample were Suppliers (32,3%), Scientific Community (16,1%), Consumers (12,9%) and Local Communities (12,9%). The categories NGOs and Shareholders are the only with no representation.

The differentiation of the stakeholders' categories was done by evaluating five attributes: *power*, *interest*, *urgency*, *legitimacy* and *support*. This evaluation used the data from the third section of the survey and, since the respondents are the stakeholders, this is a stakeholder-led evaluation.

The evaluation used a score system from 1 to 5 points, where 1 means low and 5 means high. The scores of each stakeholder category in each attribute were calculated using the mean value (μ) of the evaluations conducted by the respondents. The standard deviation (σ) and the coefficient of variation (C_V) were also calculated as statistical measures of the dispersion of the results.

In our multimethodology, the step after calculating the scores for each pair attribute/stakeholder category was to normalise these values. As the previous values are very close to each other it would be quite difficult to detect the scores' differences when analysing the results. By linearly expanding the scores through the entire evaluation scale, it is much easier to detect these differences, therefore facilitating the analysis. The normalised scores are presented in Table 2.

Table 2
Attributes' scores per stakeholder category (normalised scores)

	Management Board (OEM)	Customers	Suppliers	Services providers	NGOs	Scientific Community	Employees	Investors and Financial Institutions	Media	Consumers	Shareholders	Governments	Local Communities	Regulators
Power	5,00	4,37	3,04	2,61	1,00	2,33	1,56	4,23	2,82	1,84	3,60	4,51	1,91	4,86
Interest	4,02	3,67	3,18	3,18	3,81	4,23	2,40	2,68	2,75	2,19	2,47	3,81	3,25	3,81
Urgency	3,74	3,11	2,75	2,96	3,18	3,32	2,26	2,68	2,47	2,33	2,47	3,25	3,11	3,74
Legitimacy	4,72	4,23	3,81	3,46	3,60	4,51	3,53	3,46	2,47	3,25	4,09	4,86	4,37	4,72
Support	4,09	3,53	3,81	3,81	3,60	4,58	3,18	2,96	2,54	3,11	2,89	3,95	3,32	3,81

The scores calculated before allowed to apply some of the original methodologies which compose our multimethodology, as early indicators of the final results. The first of original methodologies to be applied was the Power-Interest Matrix, as suggested by Ackermann & Eden (2011), is presented in Fig. 3.

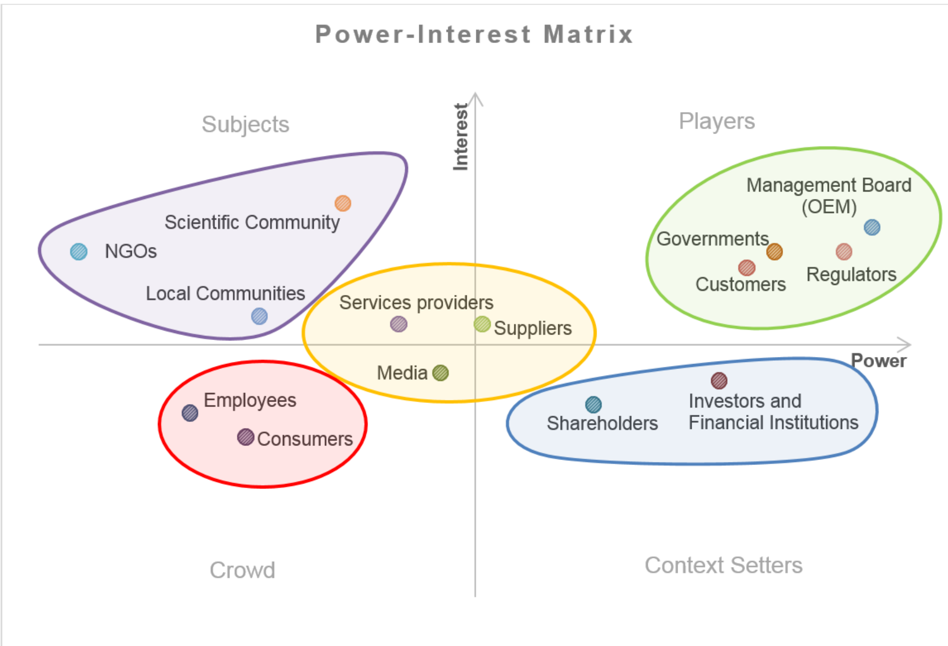

Fig. 3. Power-interest matrix

By analysing the placement of the stakeholders' categories in the power-interest matrix, it was possible to establish five clusters, which are represented by different colours.

The green cluster, characterised as 'Players' is placed in the first quadrant of the matrix, where both power and interest are high. Stakeholders in this cluster are considered the most relevant stakeholders. Two types of stakeholders' categories are placed in this cluster:

(1) Entities on the physical SC – Management Board of the OEMs and Customers. As the most powerful constituents of the physical supply chain, the Management Board of the OEMs, as representatives of the focal company, and the Customers are also highly interested in the sustainability theme. Therefore, they are considered some of the most relevant categories; (2) Governmental entities – Governments and Regulators. These are the stakeholders who legislate and regulate regarding the sustainability of the supply chain – they are the "law". Holding a high level of power and interest in the theme, these are considered as most relevant stakeholders.

The purple cluster is characterised as 'Subjects'. This is where stakeholders with low power and high interest are placed. If empowered these stakeholders can easily become 'Players'. It is interesting to observe that: (1) The Scientific Community, which is formed by the most interested stakeholders, is the most prone category to become one of the most relevant, if empowered. If they become powerful enough to bring about their desires, mostly regarding the scientific and technological advancements, they will certainty become 'players'; (2) The NGOs, although present a medium to high interest, are very unlikely to become very relevant in this industry, as commented before; (3) The Local Communities tend have a lower interest level than the other two categories. If their interest in the sustainability of the supply chain lowers, they end up becoming almost irrelevant. However, as this industry usually has a large socio-economic impact in the areas of its operation, the tendency of its local communities is to become more interested.

The red cluster is characterised as 'Crowd'. These are the stakeholders who present low levels of power and interest. Two categories were considered as 'crowd': (1) Consumers: as commented before, the most typical consumer behaviour of passengers in this industry is highly driven by the low prices. The relevance of sustainability issues for these stakeholders is usually very low; (2) Employees: several authors consider the employees as primary stakeholders. In this case, we can explain this result as the current low engagement of this stakeholders' category in the sustainability of the aerospace SC. A long-term objective regarding these stakeholders' actions in the supply chain could be to empower and improve their interest in the sustainability matters so that they become truly engaged.

The blue cluster is named as 'Context Setters'. These stakeholders hold high power while having low interest, often meaning these stakeholders can highly influence the outcomes, but not always in the best interest. In this cluster, the represented stakeholders' categories are: (1) Investors and Financial Institutions, which are the primary financial support of the supply chain, but to whom integrated sustainability is not always a priority; (2) Shareholders, to whom the environmental and social performances of the supply chain are not very important, but to whom the economic performance is crucial.

The yellow cluster was added to the original methodology and was named 'Undecided'. These stakeholders are placed almost in the middle of the matrix, meaning that small changes in both their power or interest levels can make them to be included in any other cluster. The stakeholders' categories in this situation are: (1) the Media, tending to become irrelevant; (2) the Suppliers, requiring empowerment to fully engage on sustainability and becoming main 'players'; (3) the Services Providers, which do not hold a lot of power, but could be influenced to become more interested and pursue better sustainability performances.

The Support vs Opposition Grid was the second of the original methodologies to be applied. The results from this methodology are presented in Fig. 4.

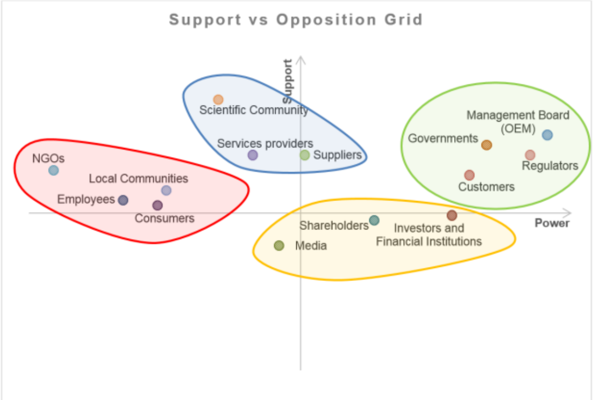

Fig. 4. Support vs opposition grid

Regarding the results from the support vs opposition grid we can verify that: (a) Most stakeholders hold a medium to high level of support, meaning that their interest in the sustainability of the supply chain is mostly positive; (b) Four clusters can be identified: (1) The green cluster, comprehending the high power and high support stakeholders, and therefore the most relevant. This cluster is composed by the same four stakeholders' categories previously identified as most relevant; (2) The blue cluster, composed by highly supportive stakeholders with medium power. These are the stakeholders who are more subject to become most relevant, if empowered. It includes the Scientific Community, as the most supportive category in terms of sustainability, and the Suppliers and the Service Providers, as entities of the physical supply who must be engaged; (3) The red cluster holds the medium supportive and low power stakeholders. Consequently, the Local Communities, the Consumers, the Employees and the NGOs are the least relevant stakeholders' categories. Following the same analysis as before, while the local communities and employees′ engagement is often considered very important, the NGOs are very unlikely to gain a lot of power in this industry. If the support of sustainability by consumers was improved, their interest in this issue could also rise and eventually become a significant stakeholders′ group; (4) The yellow cluster is composed by the least supportive stakeholders, even though they hold a medium level of support. It is important to manage the increase of support from these stakeholders, as they are also among the least interested ones and are powerful enough to impact the sustainability of the supply chain. The financial moved Shareholders and Investors, and the Media are the categories among this cluster. As discussed before, the media′s actions in this industry are often questionable, making it harder to become one of the most relevant stakeholders′ categories.

Although each one of these two methodologies only applies two of the five evaluated attributes, they can provide us with an indication of the final results regarding who are the most relevant stakeholders' categories for the aerospace sustainable supply chain. In this case, these methodologies clearly indicated as most relevant the following categories: (1) Management Board of the OEMs; (2) Regulators; (3) Governments; (4) Customers.

However, our multimethodology stakeholders′ analysis is based on the simultaneous evaluation of five attributes. Therefore, a final score is required to order the categories. To calculate a final score for each stakeholder category, as this is a multi-criteria analysis, there is the need to differentiate the contributions of each attribute score. The swing weighting methodology was applied. This methodology was conducted by the same group of experts, who gave the inputs regarding their perception of the attributes. The attributes were ordered as follows: (1) *Power*; (2) *Legitimacy*; (3) *Interest*; (4) *Support*; (5) *Urgency*. The group of experts then scored the swings from neutral to good performance in each attribute, in comparison to the most relevant attribute. The results from the application of the Swing Weighting Method are schematised in Table 3.

Table 3
Swing weighting

Attribute	Swing Score	Weights
Power	s_1=100	w_1=0,294
Legitimacy	s_2=90	w_2=0,265
Interest	s_3=80	w_3=0,235
Support	s_4=40	w_4=0,118
Urgency	s_5=30	w_5=0,088
Total	$\sum s_i = 340$	$\sum w_i = 1$

The final scores and the ordinated list of stakeholders' categories accordingly to their relevance is presented in Table 4.

Table 4
Stakeholders categories′ final scores and final relevance order

Stakeholder Category	Final Score	Final Order
Management Board (OEM)	4,48	1st
Regulators	4,35	2nd
Governments	4,26	3rd
Customers	3,96	4th
Scientific Community	3,71	5th
Investors and Financial Institutions	3,38	6th
Suppliers	3,34	7th
Shareholders	3,28	8th
Local Communities	3,15	9th
Services providers	3,14	10th
NGOs	2,85	11th
Media	2,65	12th
Employees	2,53	13th
Consumers	2,49	14th

As one of the main results from our multimethodology stakeholders' analysis, the most relevant stakeholders' categories for the sustainability of the aerospace supply chain are:

1º. Management Board of the OEMs;

2º. Regulators;

3º. Governments;

4º. Customers (Airlines);

5º. Scientific Community.

The last step of the Stakeholders' Analysis, step 6, was to create sustainability value flows between stakeholders' categories as a way to map the engagement of stakeholders towards sustainability.

This step was based on the work by Cameron et al. (2008), which presented the Value Flow Mapping Methodology. In our analysis, we chose to address the value not just in its economic pillar, but in its environmental and social pillars. Therefore, the value, as studied in this step, can acquire an economic, environmental, social or even 3BL nature.

The first step in this method was to discover the sustainability value creation inputs and outputs by the stakeholders' categories previously identified as most relevant to the aerospace SC. This step was performed based in the opinions and knowledge of the same group of experts that were consulted during the previous steps of the multimethodology stakeholders' analysis.

For the second step, the previously identified inputs and outputs were linked between stakeholders' categories. This links created sustainability value flows, which were then and classified by the group of experts regarding the nature of their value (economic, environmental, social or integrated - 3BL). The result from this step is presented as a map in Fig. 5., where the flows colours represent the nature of the value.

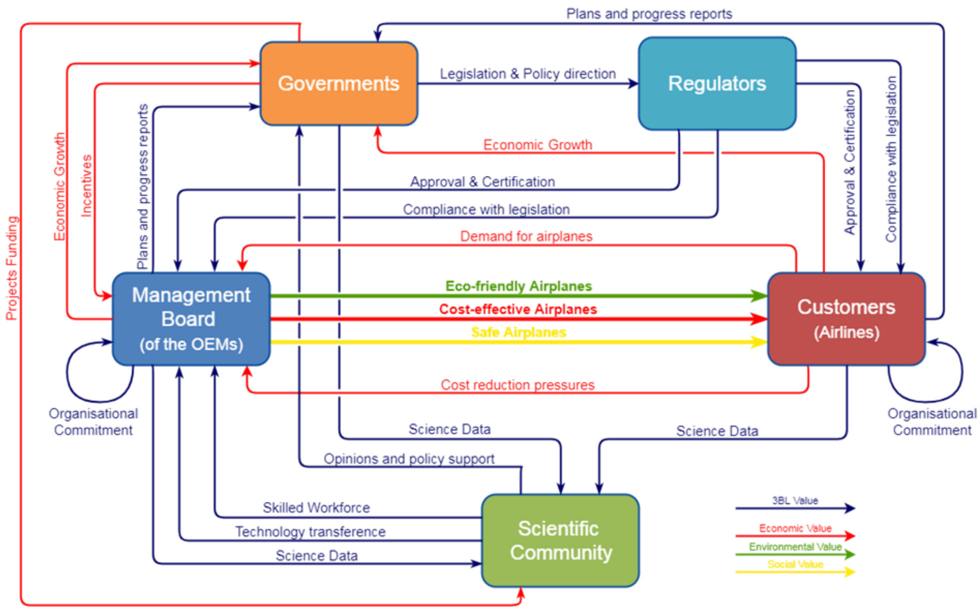

Fig. 5. Sustainability Value Flow Map

This map establishes a novel framework to the stakeholders' engagement towards sustainability in aerospace supply chains, by mapping the stakeholders' relations which create sustainable value for the supply chain.

From this analysis we conclude that: (1) Nowadays, the sustainability value flows tend to adopt the 3BL nature, therefore proving the importance and benefits of integrated sustainability. (2) Furthermore, the numerous loops that can be established within the sustainability value map often include more than one type of sustainability value, proving once more the integrated nature of sustainability. (3) The decision-making process led by these stakeholders has, more than ever, to consider the tradeoffs between economic, environmental a social value to achieve an effective stakeholders' engagement towards sustainability, throughout the supply chain.

This analysis came as the last step of the multimethodology for Stakeholders' Analysis. The following section is dedicated to measuring the stakeholders' engagement towards sustainability by developing a sustainability performance assessment framework.

3.2. Sustainability Performance: Measuring Stakeholders' Engagement

In this section, a sustainability performance reporting framework is presented as a way of measuring the stakeholders' engagement towards sustainability. This analysis is based on the results from the previously conducted stakeholders' analysis, on sustainability reporting practices from representative stakeholders, and adopted the GRI-G4 standards as a starting point to sustainability reporting. As a starting point to develop a framework for aerospace supply chain sustainability performance measurement, we analysed the GRI-G4 standards (GRI 2015), which present a set of aspects and indicators directly related to supply chains. In these standards, some indicators are suggested to evaluate sustainability performance in general supply chains. However, these indicators take a much narrower approach to the supply chain than the one used in our study, as it is very focused in the relationship between the focal company and its suppliers.

By analysing the content of the sustainability reports from organisations which are representative of the five most relevant stakeholders' categories, a set of aspects and indicators are suggested to measure the aerospace SC sustainability performance, and therefore, the stakeholders' engagement towards sustainability.

Based in the supply chain related aspects suggested by GRI-G4, and in the analysis of the actual reported information by these organisations, the group of experts suggested a set of sustainability matters as most relevant. These matters were associated to GRI standard aspects and GRI-G4 indicators to construct a Sustainability Performance Assessment methodology. The proposed framework ultimately allows the evaluation of the engagement of the several stakeholders towards the sustainability of the aerospace supply chain.

As the final framework for sustainability performance assessment, a participation planning matrix was then created to map the functions of each stakeholder category in the sustainability reporting process. Usually, in this type of matrix, the tasks (rows) are usually linked to the stakeholders (columns) by defining their responsibility towards that concrete task. In our framework, for each indicator (rows) the group of experts defined the responsibility of each stakeholders′ category (columns). Four types of responsibilities were considered: (♦) Audit; (■) Legislate; (▲) Report; (●) Research. Each sustainability matter, GRI aspect and its corresponding GRI-G4 indicators previously identified as the most relevant to this assessment were listed. The responsibilities of each stakeholder category, regarding these indicators, were defined and mapped in the matrix. The framework is presented in Table 5.

Table 5
Framework for sustainability reporting in the aerospace supply chain

	Sustainability Matter	GRI Aspect	GRI-G4 Indicators	Management Board (OEM)	Regulators	Governments	Customers	Scientific Community
Economic	Economic performance and impacts	Economic Performance	G4-EC1 G4-EC4	▲	▲♦	▲■	▲	▲
	Local socio-economic development	Indirect Economic Impacts	G4-EC8	▲	-	▲	▲	▲
	Management of supply chain	Procurement Practices	G4-EC9	▲	-	-	▲	-
Environment	Management of natural resources and waste	Energy	G4-EN3 G4-EN6	▲	♦	▲■	▲	▲●
		Water	G4-EN8 G4-EN10	▲	♦	▲■	▲	▲●
		Effluents and Waste	G4-EN22 G4-EN23	▲	♦	▲■	▲	▲●
	Atmospheric emissions & climate change	Emissions	G4-EN15/16/17 G4-EN19	▲	♦	▲■	▲	▲●
	Management of supply chain	Supplier Environmental Assessment	G4-EN32 G4-EN33	▲	-	-	▲	●
Social	Sub-category: Labour Practices and Decent Work							
	Attraction, development and retention of human resources	Employment	G4-LA1	▲	▲♦	▲■	▲	▲
		Diversity and Equal Opportunity	G4-LA12	▲	♦	▲■	▲	▲
	Employee health and safety	Occupational Health and Safety	G4-LA6	▲	♦	▲■	▲	▲
	Management of supply chain	Supplier Assessment for Labour Practices	G4-LA14	▲	-	-	▲	●
	Sub-category: Human Rights							
	Human and labour rights	Freedom of Association and Collective Bargaining	G4-HR4	▲	♦	■	▲	▲
	Management of supply chain	Child Labour	G4-HR5	▲	♦	■	▲	-
		Forced or Compulsory Labour	G4-HR6	▲	♦	■	▲	-
		Supplier Human Rights Assessment	G4-HR10	▲	-	-	▲	●
	Sub-category: Society							
	Local socio-economic development	Local Communities	G4-SO1	▲	-	♦	▲	▲●
	Ethics	Anti-corruption	G4-SO3 G4-SO5	▲	♦	■	▲	▲●
	Management of supply chain	Supplier Assessment for Impacts on Society	G4-SO9	▲	-	-	▲	●
	Sub-category: Society							
	Product safety	Labelling products and services	G4-PR4 G4-PR5	▲●	♦	■	▲●	●

♦ Audit; ■ Legislate; ▲ Report; ● Research

In this framework, we clearly suggest preference roles for each stakeholder category when participating in the aerospace supply chain sustainability reporting process: (1) The Management Board of the OEMs, as well as the Customers must adopt a reporting role; (2) Regulators must adopt an auditing role; (3) Governments must adopt a legislating role; (4) The Scientific Community must adopt researching role.

As a future development of this framework, when developing concrete indicators it is important to follow the other validation characteristics presented by Kueng (2000): (a) Sensitivity: minor performance changes should be detected by the indicator; (b) Linearity: linear dependency between performance change and indicator change is preferred; (c) Reliability: the results must be free of systematic errors and correctly calculate performance in normal and unexpected circumstances; (d) Efficiency: indicators must be cost-effective to produce and measure.

To compare sustainability performances of stakeholders as a way to measure their engagement towards sustainability in the aerospace supply chain, the implementation of standardised reporting across the supply chain's stakeholders is of the most interest. The presented framework could be used as the basis for the development of a standard for this industry. Furthermore, it is crucial that sustainability reporting evolves from an exceptional activity undertaken by a minority of organisations to a standard practice.

4. Conclusions

A multimethodology for stakeholders' analysis was developed in this dissertation, coming as a significant contribution for this area of science, as it can be adapted to other contexts and produce richer results than the existent methodologies.

The complete analysis resulted in the definition of the five most relevant stakeholders' categories, in the context of the aerospace supply chain sustainability, to be: (1) Management Board of the OEMs; (2) Regulators; (3) Governments; (4) Customers; (5) Scientific Community.

A framework for sustainability performance reporting was presented as a way of measuring the stakeholders' engagement towards sustainability in the aerospace supply chain.

As future work, first we recommend enlarging the survey's sample size to produce more robust results. It would also be interesting to test this novel multimethodology for stakeholders' analysis in other contexts, such as other industries or other issues. Regarding the sustainability performance assessment, we recommend the development of concrete indicators based in the presented framework and testing its application on a case study.

5.References

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