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Rating ESG key performance indicators in the airline industry

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Abstract

The environmental, social, and governance (ESG) integration finds itself in a transition with rapid developments worldwide, given that the pandemic incentivized companies and investors to focus on other social and governance measures such as ESG ratings. However, the divergence of ratings from the ESG and a lack of transparency lead the companies to report voluntary indicators without standardization. This study aimed to identify the ESG criteria and the most suitable set of key performance indicators (KPIs) in the airline industry after the impact of COVID-19. Furthermore, the second objective was to determine the appropriate weights and ranking of the identified criteria. The multi-criteria decision-making analytical hierarchical process was applied for this purpose. Additionally, the use of intuitionistic variables delivers a comprehensive model for rating the airlines according to their ESG performance. The most relevant criteria found in the study were critical risk management, greenhouse gas emissions, and systemic risk management. Regarding the KPIs, the top-3 weights were the number of flight accidents, jet fuel consumed and sustainable aviation used, and the number of digital transformation initiatives.

Keywords ESG · CSR · Sustainability · Performance · KPI · COVID-19

1 Introduction

Since the emergence of the COVID-19 pandemic, governments across the globe have introduced rapid economic rescue actions in hopes of protecting their companies and their people. As the pandemic remains uncertain, countries seek to implement measures that enhance and preserve both short-term and long-term prosperity. One of these measures includes the transition to a more inclusive and resilient society with zero greenhouse gas (GHG) emissions (OECD, 2020). Corporate actions integrating these measures are often called Environmental, Social, and Governance (ESG) or Corporate Social Responsibility (CSR). Gillan et al. (2021) defined ESG as how stakeholder groups, i.e., investors, employees, communities, environmentalists, consumers, and corporations, integrate governance, environmental, and social concerns into their business models. ESG includes a governance

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dimension, whereas CSR generally refers to corporate activities regarding social responsibility but indirectly addresses governance issues. Hence, ESG is a broader term than CSR. Nonetheless, in this paper, both terms hold equal weight regarding sustainability. As published by the Global Sustainable Investment (2021) review, ESG integration finds itself in a transition with rapid developments worldwide, reshaping sustainable investment toward the best standards of practice. For example, there was a 15% increase in sustainable investment over the past two years, reaching USD 35.3 trillion in major markets.

The disruption caused by the pandemic incentivized companies and investors to focus on other social and governance measures, such as ESG ratings. Higher scores may indicate a better opportunity to cope with crisis scenarios, suggesting a firm's capability of mitigating the associated risks. Subsequently, companies with more decisive ESG actions are expected to be more resilient in unstable market situations (Díaz et al., 2021). Despite the global focus, ESG is a concept that is still developing. While financial reporting standards have matured over the decades, ESG reporting is still unclear. As stated by Berg et al. (2019), most leading companies report an outline of voluntary ESG indicators without following a mandatory framework for all of them. Consequently, ESG raters provide their services by gathering and aggregating data across various sources, frameworks, and reporting standards. The expected result is the divergence of ratings from the ESG agencies to the assessed institutions and a lack of transparency regarding the methodologies used to measure the scores. Escrig-Olmedo et al. (2019) acknowledge issues such as the inconsistency of the assessments, the lack of overall scores of some rating agencies, and the lack of incorporation of the stakeholders in the evaluation process.

The airline industry faces challenges regarding its environmental impacts on the climate. The burning of jet fuel and the release of pollutant gases endanger global air quality (Abdi et al., 2020). Carbon dioxide (CO₂) is the main greenhouse gas producing the warming of the atmosphere. The International Air Transport Association (IATA, 2021d) reported that worldwide flights emitted 905 million tonnes of CO₂ in 2019. However, the pandemic reduced this number to 495 million tonnes in 2020 due to travel restrictions and parked aircraft. Nevertheless, the rebound is expected to challenge the airlines to develop strategic sustainability measures for the upcoming years. The increasing awareness of adopting CSR has permeated the aviation sector as it also represents the brand image and reputation due to its significant role compared with other industries (Lee et al., 2018). Therefore, the airlines are aligning their strategies by integrating socially responsible aspects into their business practices to further sustainable development (Abdi et al., 2020). Nonetheless, air travel companies with high capital intensity and external debt are hesitant regarding ESG/CSR implementation due to their corporate financial performance. This situation impacts the compliance of airlines to develop CSR based on financial performance, affecting their sustainability strategies (Kuo et al., 2021). Although airlines have implemented these strategies, the percentage is still low compared to other sectors. Another challenge facing the airlines is selecting the best ESG indicators to prioritize implementation, considering aspects as operating costs, brand image, reputation, and profitability (Kuo et al., 2021). As Hristov and Chirico (2019) emphasized, there is a gap of updated literature regarding general sustainability KPIs for evaluating their ESG performance, as verified in this paper, as in the airline industry.

This study aimed to identify the ESG criteria and the most suitable set of key performance indicators in the airline industry after the impact of COVID-19. Furthermore, the second objective was to determine the appropriate weights and ranking of the identified criteria. The final goal was to propose a comprehensive model for rating the airlines according to their ESG performance. The findings can provide relevant implications for

ESG analysts and airlines regarding measuring and reporting their sustainability KPIs. This approach deals with the sustainability challenges faced by the airline industry, which holds significant value for academics, practitioners, and policymakers alike. Moreover, the findings of this study can be directly applied in practice. The recent United Nations Climate Change Conference (COP26) underscored the importance of addressing the environmental initiatives highlighted in this research. The paper's discoveries also have the potential to strengthen the airline industry's sustainability and resilience in the aftermath of the COVID-19 impact. By prioritizing ESG KPIs, airlines' practitioners, and policymakers can proactively prepare for future disruptions and showcase their dedication to long-term sustainability. Additionally, the proposed model can be adopted by airlines to assess their performance in comparison to competitors and improve their ESG practices. The research met these objectives by addressing the following research questions: (a) What are the current KPIs reported by the airlines, and how important are they? (b) What are the major agencies in sustainability reporting? And (c) Are the analytic hierarchy process (AHP) and intuitionistic variables suitable to calculate the ESG performance of the airlines?

The next section of this paper consists of: Sect. 2 includes a literature review introducing the use of ESG in the airline industry and other sectors and then proceeds with a cross-case analysis of sustainability reports in specific airlines. Additionally, Sect. 2 analyses the literature gap. In contrast, Sect. 3 thoroughly describes the research methodology. Section 4 depicts the resultant ESG criteria and key performance indicators and presents the weights and ranking obtained in the survey. Moreover, the section calculates the ESG rating and delivers the results of the model. Lastly, Sect. 5 discusses the findings, followed by the conclusion and suggestions for future research.

2 State of the arts

2.1 ESG in the airline industry

Various studies focused on ESG/CSR in the airline industry in recent years. Abdi et al., (2020, 2021) investigated the sustainability performance within airlines. The scholars addressed the impact of ESG on the firm value and financial performance and the potential moderating role of firm size and age in the air transport industry. Similarly, other academics (Kuo et al., 2021) measured the ESG impact on the short-term financial performance of 30 worldwide airline companies.

Coles et al. (2014) examined the CSR practices in low-cost European airlines, while Cowper-Smith and de Grosbois (2011) identified CSR initiatives and the state of adoption among three large airline groups. Al Sarrah et al. (2021) explored the relationship between the civil aviation industry and sustainability considerations involving the role of stakeholders. The paper identified a vast number of CSR criteria.

Chang et al. (2015) evaluated a model for Asia-Pacific airlines to examine the critical strategic factors in CSR implementation. On the other hand, Karaman and Akman (2018) proposed an analytic hierarchy process (AHP) model to identify key factors regarding criteria and sub-criteria of CSR programs in the Turkish airline industry. Kılıç et al. (2019) studied the relationship between Global Reporting Initiative (GRI) reporting and firm performance. Comparably, Karaman et al. (2018) tested the link between sustainability reporting and sustainability performance.

Meanwhile, Lee et al. (2018) analyzed the materiality issue for the airline industry by comparing low-cost and full-service carriers. The Sustainability Accounting Standards Board (SASB) Materiality Map was utilized to measure firm performance. One year later, Stevenson and Marintseva (2019) reviewed the Fuzzy Set Theory for the formation of criteria and assessed a company's CSR behavior and reporting techniques to discuss the effectiveness of the reporting standards in European airlines. The overview of the studies in the airline industry is shown in Table 1.

2.2 Criteria comparison with other sectors

The five major frameworks and disclosure of standards are the global reporting initiative (GRI), the sustainability accounting standards board (SASB), the international integrated reporting council (IIRC), the climate disclosure standards board (CDSB), and CDP (CDSB, 2020). As reported by KPMG (2020), GRI is the leading framework used by around two-thirds of the top 100 companies ranked by revenue. The report also establishes that the SASB standard is the most frequently utilized for sustainability reporting regarding other guidelines and standards.

In Table 2, the SASB standard was utilized to illustrate the differences and similarities of ESG criteria in the airlines and other sectors of the transport industry. The “greenhouse gas emissions” criterion is one of the most critical for the whole transportation sector. According to European Environment Agency (2021), road transport emitted 72% of all GHG in 2019. However, the percentage is expected to decrease because road transport decarbonizes faster than the other modes of transportation. The aviation sector is projected to increase up to 2030 in conjunction with maritime transport.

Table 1 Literature overview

ESG research in airline industry	Financial performance	CSR initiatives and practices	CSR key factors and criteria	CSR performance	Sustainability reporting
Abdi et al. (2021)	X				
Kuo et al. (2021)	X				
Al Sarrah et al. (2021)			X		
Abdi et al. (2020)	X				
Stevenson and Marintseva (2019)					X
Kılıç et al. (2019)				X	X
Karaman and Akman (2018)			X		
Lee et al. (2018)	X	X			
Karaman et al. (2018)				X	X
Chang et al. (2015)			X		
Coles et al. (2014)		X			
Cowper-Smith and de Grosbois (2011)		X			

Table 2 Comparison transportation sector

Criteria	Airlines	Air freight logistics	Auto parts	Auto mobiles	Car rental leasing	Cruise lines	Marine transport	Rail transport	Road transport
GHG emissions	X	X		X		X	X	X	X
Air quality		X				X	X	X	X
Energy management			X						
Water and wastewater management						X			
Waste and hazardous material management			X				X		
Ecological impacts						X			
Product quality and safety			X	X					
Customer welfare					X				
Labor practices	X	X		X		X		X	X
Employee health and safety		X							
Product design and lifecycle management			X						
Supply chain management		X							
Materials sourcing and efficiency			X	X					
Business ethics							X		
Competitive behavior	X		X					X	
Critical incident risk management	X	X					X	X	X

2.3 Sustainability reports in the airline industry

The following section exemplifies the lack of standardization in the sector regarding KPIs reporting through cross-case analysis. The selection of the air travel groups was based on the highest CO₂ emissions in Europe as of 2021 (Mazareanu, 2021). Three flag carriers appear in the top positions and one low-cost carrier in fourth place. Relevant data from their sustainability reports are given in Table 3.

2.4 Literature gap analysis

As stated by Lydenberg et al. (2010), global activities hinder the determination of performance indicators. The variety of industries, along with the different methodologies across countries, establish complications in evaluating criteria for the rating agencies. The complexity obliges the raters to delimit manifold sets of KPIs, and thus, companies only produce voluntary reports addressing ESG issues. Nevertheless, mandatory reporting of a defined group of criteria could intensify peer-to-peer comparisons to determine current positioning and identify opportunities. In the case of the airline industry, there is no specific selection of attributes and standardized key performance indicators as verified in the airline's sustainability reports.

Another gap to point out is the heterogeneity of the weighting evaluation. Rating agencies take different perspectives on the relative importance of criteria and whether performance in one attribute alters another (Berg et al., 2019). The rater's methodologies to measure customers from distinct sectors remain unclear. Dow Jones appears more consistently in the aviation literature in partnership with RobecoSAM. This sustainability system, however, only displays its constituents without specifying the weights in their index factsheet (Diez-Cañamero et al., 2020; Escrig-Olmedo et al., 2019).

The airline industry literature related to established KPIs and weighting methods to determine ESG performance is limited and requires enhanced development. This research addresses the gap through a new level of analysis.

3 Methodology

In this paper, a fifth-phase methodology was developed to address the research objectives and fill the respective research gap. In the first step, the main ESG criteria were identified based on one of the sustainability reporting standards. Then, the sub-criteria were determined conjointly with two aviation organizations. The sub-criteria reflect the key performance indicators required for further steps. In phase III, experienced aviation and sustainability professionals were selected and contacted to perform a questionnaire. Thereafter, the relative weights were calculated based on the answers of the respondents using the analytic hierarchy process (AHP) method. Lastly, two alternatives were compared to illustrate the functionality of the model using the intuitionistic variables. The flow diagram of the methodology is depicted in Fig. 1.

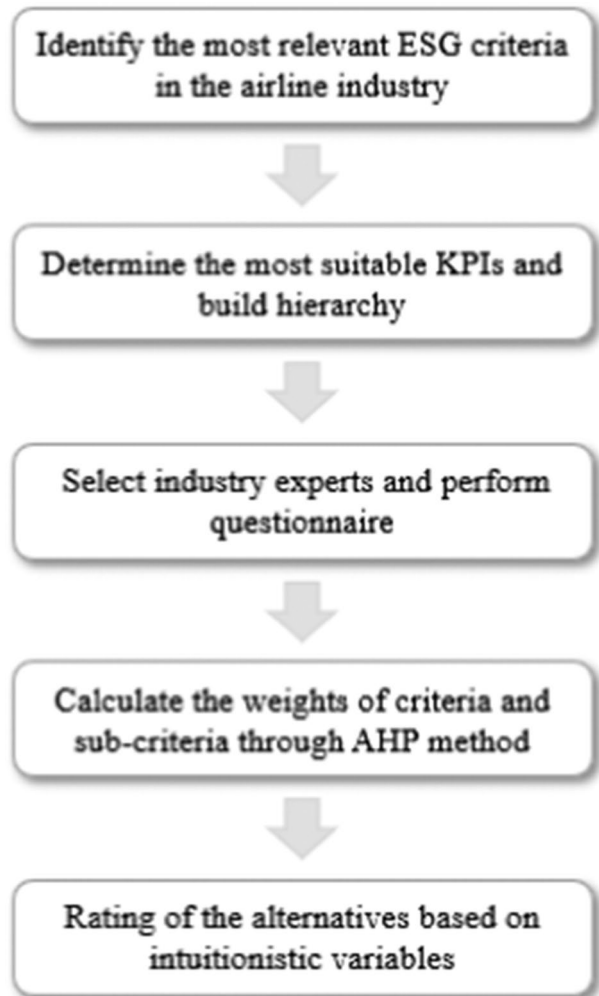
3.1 ESG main criteria

The first step to address the research gap required an analysis of the main criteria in the airline industry. The scarcity of aviation literature led to the use of established standards.

Table 3 Airline's sustainability reports

Data	Lufthansa (Lufthansa Group, 2020)	Air France-KLM (Air France-KLM Group, 2018, 2020)	IAG (IAG Group, 2020)	Ryanair (Ryanair Group, 2020)
Frameworks/standards	GRI, TCFD, SASB	GRI	GRI, TCFD, SASB, IATA	No data available
ESG ratings	CDP, MSCI, Sustainalytics, ISS, Vigeo Eiris, EcoVadis	Dow Jones, CDP, Vigeo Eiris, ISS	CDP, TPI	No data available
Fuel consumption	Total per year, per passenger, per freight transportation	Percentage of fuel reduction, total SAF purchased	Total jet fuel per year	Percentage of fuel reduction
CO ₂ emissions	Total per year, per passenger transportation	Total Scope 1, 2, 3	Total Scope 1, 2, 3	Monthly, per passenger
Other emissions	Nitrogen oxide, carbon monoxide, unburned hydrocarbons	Percentage of NOx reduction	NOx per cycle	No data available
Noise	Number of aircraft meeting the limit	Percentage of noise reduction	Noise per cycle	Noise reduction per seat
Employees	Engagement index, age, share of women in management positions and staff	Percentage of female managers	Age, share of women in management positions and staff	Age, share of women in management positions and staff
Carbon offset	By airline, employees, passengers	Compensation service CO2ZERO	By airline, passengers	By passengers
Climate projects	Fuel-Saving, Smart Plastic, SAF, Efficient aircraft	Tropical forest, aircraft retired, modern aircraft	GHG reduction initiatives, SAF development	Aircraft technology, SAF development
Social projects	Aid projects, education donation	Wings of support	Donations, Red Cross, Save the Children	Ugandan Cookstoves and Malawi Kitchen projects
COVID-19	Purchase of masks	Repatriation flights	Flights of medical equipment between Europe and China	No data available

Fig. 1 Methodology flow diagram



More than 1000 sustainability professionals consider the Dow Jones Sustainability Indices as the index with the highest credibility within worldwide endorsed ratings. They perform an individual questionnaire for different sector groups. Nonetheless, the airline industry copes with specific ESG issues outside the scope of other sectors (Chang et al., 2015).

The Sustainability Accounting Standards Board (SASB) identifies, manages, and communicates financial materiality and sustainability information to investors. SASB standards are industry-specific, identifying the subset of issues and providing the performance indicators in the corresponding industry to support their sustainability reporting. Frameworks and disclosure standards, including GRI and SASB, facilitate the comparison of ESG information, and therefore, provide the resources for rating agencies in their analysis (GRI & SASB, 2021).

This study deploys the SASB standards due to its financial materiality impact and industry-specific focus. The criteria selected are based on these standards but adapted according to the findings from air travel literature. The highest classification involves the dimensions

of “Environment”, “Social”, and “Governance”. Economic factors are out of the scope of this research.

3.2 KPIs selection

Subsequently, this research elaborated on the selection of intrinsic performance indicators. Ultimately, the evaluation explored the SASB standards and expanded upon the field by covering additional specific airline industry issues. The influential organizations focusing on aviation activities are the Air Transport Association (IATA) and the International Civil Aviation Association (ICAO).

IATA is a non-governmental entity concerned with developing global commercial standards to ensure safety and efficiency for travelers. One of their priorities is environmental and social sustainability promoting green activities and programs as Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), sustainable aviation fuel (SAF), and aircraft decommissioning (IATA, 2021c). Furthermore, they launched industry-wide diversity and inclusion initiatives, considering them essential for business success (IATA, 2021a).

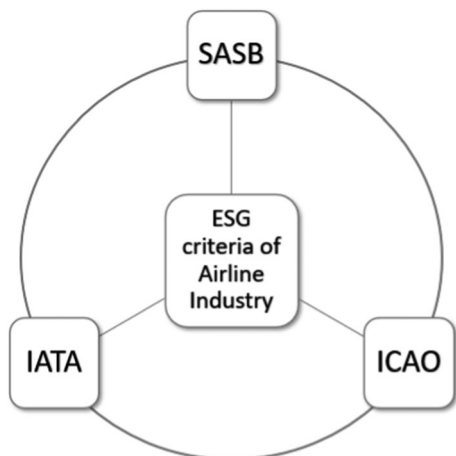
ICAO is a United Nations agency whose core function is to support diplomatic interactions among national governments regarding air transport activities and research new air transport policies as standardization innovation. Their reports and recommendations in sustainability include topics regarding air pollution, aircraft noise, energy management, clean technology, and digitalization (ICAO, 2021).

The present study collected the criteria and KPIs according to IATA and ICAO literature and SASB standards, as shown in Fig. 2. The criteria summary is depicted in Sect. 4.1.

3.3 AHP method and survey design

The prioritization of KPIs requires a multi-criteria decision-making (MCDM) approach. Shahin and Mahbod (2007) consider AHP the most powerful and universally used tool for MCDM. It permits the decision-maker to measure consistency and has proven its value by prioritizing performance indicators.

Fig. 2 ESG criteria of airline industry



Creating a hierarchy of a problem is the foundation of the AHP method. The structure is generated based on the criteria selected, starting from the primary goal and subdividing it into lower levels. The ultimate goal is to rate the ESG performance of the airlines. Level 1 is represented by the main criteria, and level 2 by the KPIs. The description of the latter was shortened for illustrative purposes. Moreover, the criteria containing only one performance indicator were omitted from level 2. The survey follows this hierarchy to present the questionnaire to industry professionals. The hierarchical model diagram is given in Fig. 4.

The size of respondents is relevant for an adequate analysis. Thomas Saaty, the architect of the AHP method, validates that a jury size between six and eight members is optimum to minimize errors (Saaty & Özdemir, 2014). According to Herath (2004), as cited by Rahman et al. (2019), AHP requires an analytical sampling rather than a statistical one. The experiment performed by Tsyganok et al. (2012) concluded that the expert competence of small group sampling should always be considered.

In the present research, seven experts participated in the AHP questionnaire. The study area is European airlines, and thus, the group was selected to focus on the sustainability issues in this region. The experts demonstrate at least 4–5 years of experience in the aviation field, and six of them have engaged in sustainability activities for at least 1–3 years. Table 4 provides details on the profiles of the participants.

The questionnaire given to the experts performs a pairwise comparison by Saaty's nine-point scale that helps to identify the relative importance of one alternative from the other (Saaty, 1980). The scale is illustrated in Table 5. For example, if the respondent determines that criteria A has moderate importance over B, then $X_{AB}=3$. On the contrary, $X_{BA}=1/3$.

3.4 Weights calculation

Once all the pairwise comparisons were completed, an average pairwise comparison matrix was created to interpret all the participant's judgments for the criteria and sub-criteria. The geometric mean method was used to aggregate the individual judgments, given that this method meets the axiomatic conditions of the reciprocal property.

The responses from the industry experts were computed by the AHP-OS software created by Klaus Goepel. The system handles all the standard AHP calculation steps and permits the visualization of the normalized weights of all the criteria and sub-criteria. Moreover, the software determines the group consensus based on Shannon entropy. The range

Table 4 Survey participant data

Expert	Background	Gender	Experience in the aviation industry	Experience in ESG/sustainability
# 1	Sustainable aviation consultant	Male	6–10 years	4–5 years
# 2	Sustainable aviation consultant	Female	15+ years	1–3 years
# 3	Senior project manager	Male	4–5 years	4–5 years
# 4	Aviation environmental consultant	Female	4–5 years	4–5 years
# 5	Vice President global airlines	Female	6–10 years	Not applicable
# 6	Sustainability manager global airlines	Female	4–5 years	4–5 years
# 7	ESG manager global airlines	Male	4–5 years	6–10 years

Table 5 Saaty scale

Intensity of weight	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objectives
3	Weak/moderate importance	Experience and judgement slightly favored one activity over another
5	Essential or strong importance	Experience and judgement strongly favored one activity over another
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation

categories are shown in Table 6. Goepel (2018) calculates the consistency ratio (CR) based on the linear fit proposed by Alonso and Lamata (2006). This ratio determines the degree of reliability and consistency of judgments. The acceptable value in the method is ≤ 0.10 . The ratio formula is given in Eq. (1).

$$CR = \frac{\lambda - n}{2.7699 \cdot n - 4.3513 - n} \quad (1)$$

3.5 Rating by intuitionistic variables

Intuitionistic fuzzy set (IFS) is a theory that incorporates expert's influence as intuitionistic data into the multiple criteria decision making (MCDM) environment by using linguistic terms (Atanassov, 1986). The methodology is based on a decision matrix containing fuzzy data ranges derived from fuzzy intuitionistic variables. The variables used in this study are depicted in Table 7.

Karaman and Akman (2018) developed a similar approach of linguistic variables in the airline industry as in this research. However, this study utilizes negative and positive indicators according to the type of criteria measured. Egilmez et al. (2015) addressed the sustainability performance of U.S. and Canada metropolises through this intuitionistic approach.

The calculation starts with the classification of intuitionistic datasets into histograms. The data are decomposed based on the percent distributions shown in Table 8. An example is illustrated for the sub-criteria "Fuel Consumption", which contains two types of key performance indicators: total jet fuel consumed and the percentage of sustainable aviation fuel used. The former is a negative sustainability indicator and the latter a positive one. For illustrative purposes, the negative indicator of jet fuel consumed by the airlines is shown in Table 9 and Fig. 3.

The upper bound element determines the rest of the intervals of the histogram. It is worth mentioning that this model is relatively flexible due to its capacity of substituting the upper bound for a specific target that could match the Paris Agreement climate change framework. After the classification of the histogram intervals, the fuzzy variables are assigned to each element, where the values go from 0 to 1 (see Table 10). The resultant coefficients are considered for rating the airlines' ESG performance along with the global weights obtained from the AHP method.

Table 6 Group consensus categories

Range	Consensus
$\leq 50\%$	Very low
50–65%	Low
65–75%	Moderate
75–85%	High
$\geq 85\%$	Very high

Table 7 Intuitionistic variables

Positive indicators (+)	Negative indicators (–)
Excellent (EX)	Extremely high (EH)
Very good (VG)	Very high (VH)
Good (G)	High (H)
Medium (M)	Medium (M)
Poor (P)	Low (L)
Very poor (VP)	Very low (VL)
Extremely poor (EP)	Extremely low (EL)

4 Research results

4.1 Criteria selection

4.1.1 Main criteria

The resultant main criteria are presented in Table 11. The attributes were chosen based on the SASB disclosures. The composition includes five environmental measures, three from the social dimension and three from governance. SASB “Air Quality” criterion was included as a sub-criterion in the “GHG emissions” category. The “Noise” and “Environmental Opportunities” were added to the overall model. “Waste and Material Management” and “Systemic Risk Management” were customized according to the airline industry issues. Figure 4 depicts a complete hierarchical model for measuring ESG performance.

4.1.2 Key performance indicators

The key indicators gathered from the SASB in conjunction with the aviation organizations are given in Table 12. The measures provided are not a definitive set of KPIs for the airline industry. The selection could expand by considering other standard-setting organizations. However, companies find it challenging to report numerous KPIs from different frameworks (Dissanayake, 2021). This paper exposes twenty indicators for the selected 11 main criteria.

The “Greenhouse Gas Emissions” criterion involves three sub-topics, same as the “Environmental Opportunities”. “Labor Practices” entail two sub-criteria in the social dimension, and “Employee Engagement and Diversity & Inclusion” in the same matter. “Critical

Table 8 Percentile distributions

Indicator	Variables	Percentage share (%)	Cumulative percentage
+	Excellent (EX)	5	5
–	Extremely low (EL)		
+	Very good (VG)	10	15
–	Very low (VL)		
+	Good (G)	15	30
–	Low (L)		
+	Medium (M)	40	70
–			
+	Poor (P)	15	85
–	High (H)		
+	Very poor (VP)	10	95
–	Very high (VH)		
+	Extremely poor (EP)	5	100
–	Extremely high (EH)		

Table 9 Example of transformation of fuzzy terms

Airline ID	Jet fuel (million tonnes)	Fuzzy term
AIR1001	5	M
AIR1002	7.5	VH
AIR1003	3.5	M
AIR1004	2	L
AIR1005	8	EH
AIR1006	3	M
AIR1007	7.3	VH
AIR1008	1.5	L
AIR1009	6	H
AIR1010	0.3	EL

Risk Management” considers flight accidents and governmental actions. Finally, “Systemic Risk Management” depicts three sub-criteria related to the travel system collapse.

4.2 Weighting results

Table 13 presents the analysis of the survey responses computed in the online system AHP-OS. The judgments were calculated based on the standard AHP linear scale. The system determined the overall weights of the first-level hierarchy and the second-level hierarchy. Moreover, the online tool permits the ranking of these levels.

In Table 14, the global weights were assigned to each key performance indicator identified in Table 12. These weights were obtained by multiplying the criteria weights by the sub-criteria weights. For example, the global weight obtained for the KPI “Number of accidents” is 0.173, the resultant product proceeds from the multiplication of “Critical Risk Management” criteria (0.217) and the sub-criteria “Flight Accidents” (0.795).

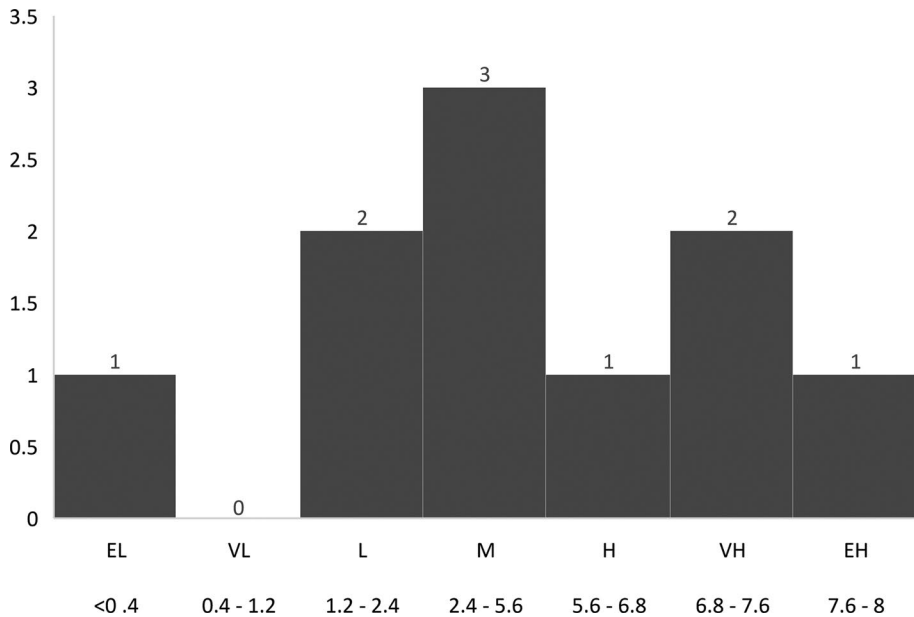


Fig. 3 Histogram of jet fuel consumption

Table 10 Definition of coefficients

Evaluation of alternatives	Intuitionistic fuzzy numbers (IFN)
(EX, EH)	(0.98, 0.02)
(VG, VH)	(0.75, 0.15)
(G, H)	(0.65, 0.25)
(M)	(0.50, 0.35)
(P, L)	(0.35, 0.55)
(VP, VL)	(0.15, 0.75)
(EP, EL)	(0.02, 0.98)

The software also computed the consistency ratio (CR) to determine the degree of reliability of the responses. The acceptable value for the AHP method is lower than 10%. Furthermore, the results were reviewed with the participants in case of inconsistencies. Additionally, the software measured the consensus for the aggregated group result. Table 15 presents the breakdown of these values obtained from the online tool.

4.3 Rating calculation

Table 16 simulates the calculation of the ESG performance of two airlines to demonstrate the functionality of the proposed model. The global weights (GW) were determined by the AHP method in Table 14 and the intuitionistic fuzzy numbers (IFN) from

Table 11 ESG main criteria of the airline industry

Dimension	Main criteria	Description
Environment	Greenhouse gas emissions (GHG)	Covers direct Scope 1 emissions, air quality pollutants and fuel consumption
	Energy management	Covers Scope 2 emissions associated with energy consumption
	Noise	Standard of noise limit set by the ICAO
	Environmental opportunities	Includes initiatives as CORSIA (Carbon Offsetting Scheme), clean technology and digitalization
	Waste and materials management	Related to aircraft decommissioning (retirement of aged aircraft) and recycling of parts
Social	Community relations	Includes social initiatives (health, education, etc.) and charity donations
	Labor practices	Related to employee strikes, lockouts, and turnover rate
	Employee engagement, diversity and inclusion	Covers the levels of employee engagement and diversity inclusive groups
Governance	Competitive behavior	Addresses legal management associated with anti-competitive practices
	Critical incident risk management	Related to the culture of safety and prevention of high-impact accidents
	Systemic risk management	Involves the management of risks resulting from large-scale travel system collapse (unavailable routes)

Table 10. The intuitionistic variables were randomly assigned and converted into the respective coefficient.

The final scores determined that “Airline 02” obtained a higher ESG performance than “Airline 01”. The former accomplished its score due to its outstanding practices in environmental opportunities such as digitalization and clean tech, in conjunction with the mitigation of the number of impacted flights, restricted destinations, and parked aircraft.

5 Discussion of findings

5.1 Relevant criteria and KPIs

According to the weights and ranking from Table 13, the most relevant main criterion for the rating of ESG is “Critical Risk Management”. The questionnaire described it as a criterion related to the culture of safety and prevention of high-impact accidents. The experts acknowledged safety as the number one priority consistently with IATA’s primary goals (IATA, 2021e). The aviation association mentions that safety risk assessment is vital to manage the risks raised by disruptions generated by COVID-19. For this primordial criteria, the KPIs determined include the “number of governmental enforcement actions of aviation safety regulations” and the “number of flight accidents”. The latter was the highest performance indicator overall, with 17.3%.

The second most critical main criterion was “GHG Emissions”. The subjects of “scope 1 emissions”, “fuel consumption”, and “air quality pollutants” defined the importance of this criterion. The representatives of the International Aviation Climate Ambition Coalition during the recent United Nations Climate Change Conference (COP26), recognized the impact of COVID-19 on the global aviation sector and the need to develop initiatives for reducing the aviation sector’s contribution to climate change (United Nations Climate Change Conference, 2021). As stated in Eurocontrol (2021), sustainable aviation fuel (SAF) is one of the key initiatives to deliver decarbonization goals toward net-zero emissions for the aviation sector by 2050. Additionally, the KPI, “total jet fuel consumed (tonnes) and percentage of sustainable aviation fuel used,” weigh 7.6% and is positioned within the second level of relevance and demonstrates a high impact on the ESG performance rating.

The third most relevant main criterion is “Systemic Risk Management”, which involves managing risks resulting from large-scale travel system collapse (unavailable routes). According to a study performed by Stauffer and Poolman (2020) from S&P Global, COVID-19 exposed the aviation industry’s lack of pandemic risk preparedness, where companies neglected to report mitigating actions related to COVID-19 disruptions. The proposed KPIs in this paper, such as the “number of impacted flights”, “restricted destinations”, and “parked aircraft”, support adaptive operations management in a crisis scenario. However, airlines should establish beforehand their disruption preparedness, response, and recovery plans.

The following criterion in the level of relevance was “Environmental Opportunities”. The KPI with the higher weight below this topic was “number of digital transformation initiatives fully implemented”, with a percentage of 7.2. Even though airlines find themselves in financial uncertainty, the surveyed experts considered this indicator relevant for sustainability development. After the pandemic, the consulting firm McKinsey & Company recommends investing more in IT and digitalization. Airlines are aware of their importance. Nonetheless, before the global health crisis, air travel companies spent roughly 5 percent of their revenue on IT, a relatively low percentage compared to other sectors (Bouwer et al., 2021). The introduction of digital initiatives is an area with considerable improvement for the airline industry.

The other explored sub-criterion regarding “Environmental Opportunities” includes “clean technology” and the “carbon offsetting scheme”. The industry professionals considered the sub-criteria to be of relevance in the second and third positions, respectively.

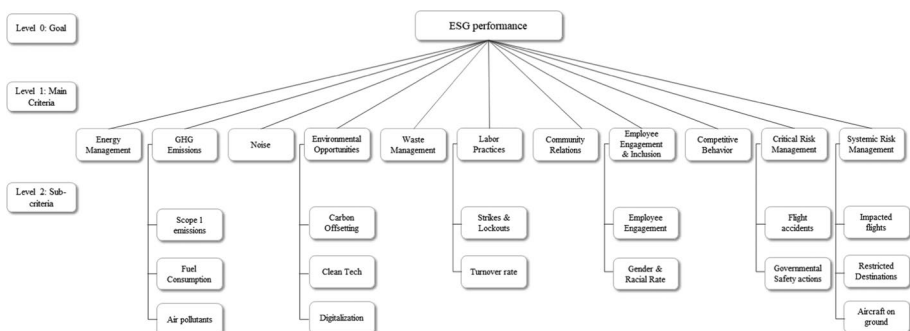


Fig. 4 Hierarchical model for measuring ESG performance

Table 12 Set of key performance indicators

Main criteria	KPIs	Source
Greenhouse gas emissions (GHG)	Gross global Scope 1 emissions (metric tonnes CO ₂ -e) and emissions per passenger	SASB (2014)
	Total jet fuel consumed (tonnes) and the percentage of sustainable aviation fuel used	IATA (2019b)
	Total air emissions of pollutants NO _x , SO _x , and particulate matter (metric ton CO ₂ -e)	IATA (2019b)
Energy management	Gross global Scope 2 emissions (metric tonnes CO ₂ -e)	ICAO (2010)
Noise	Percentage of aircraft that meet or exceed – 10 dB criterion	ICAO (2019b)
Environmental opportunities	Total airline carbon offset and percentage of voluntary passenger carbon offset	IATA (2020a)
	Total number of aircraft propelled by both fuel and an electric battery	ICAO (2019a)
	Number of digital transformation initiatives fully implemented	ICAO (2020)
Waste and materials management	Total retired aircraft from operational service and percentage of re-used parts and recycled materials	IATA (2021b)
Community relations	Number of social initiatives and charity donations	ICAO (2016)
Labor practices	Number and duration of strikes and lockouts	SASB (2014)
Employee engagement	Employee turnover rate	IATA (2019a)
	Levels of employee engagement	IATA (2019a)
	Percentage of gender and racial/ethnic group for managerial and technical staff	IATA (2021a)
	Total amount of legal and regulatory fines	SASB (2014)
	Number of accidents	SASB (2014)
Critical incident risk management	Number of governmental enforcement actions of aviation safety regulations	SASB (2014)
	Number of impacted flights	IATA (2020b)
	Number of restricted destinations	IATA (2020b)
	Number of parked aircraft/aircraft on ground	IATA (2020b)

Table 13 Overall weights of the criteria and sub-criteria

Criteria and sub-criteria	Level 1 weights	Criteria ranking	Level 2 weights	Sub-criteria ranking
Energy management	0.048	8		
Noise	0.028	11		
Waste management	0.066	6		
Community relations	0.036	10		
Competitive behavior	0.045	9		
GHG emissions	0.153	2		
Scope 1 emissions			0.308	2
Fuel consumption			0.499	1
Air pollutants			0.193	3
Environmental opportunities	0.131	4		
Carbon offsetting			0.129	3
Clean tech			0.322	2
Digitalization			0.55	1
Labor practices	0.08	5		
Strikes & lockouts			0.605	1
Turnover rate			0.395	2
Employee engagement, diversity and inclusion	0.057	7		
Employee engagement			0.391	2
Gender and racial rate			0.609	1
Critical risk management	0.217	1		
Flight accidents			0.795	1
Governmental actions			0.205	2
Systemic risk management	0.139	3		
Impacted flights			0.489	1
Restricted destinations			0.284	2
Aircraft on ground			0.227	3

The KPI “total airline carbon offset and percentage of voluntary passenger carbon offset” placed last in the set of indicators with 1.7%. The objective of CORSIA is to compensate for the growth of international aviation CO₂ emissions. By itself, the carbon offsetting scheme appears to hardly contribute to climate neutrality by 2050 (European Commission, 2021). This program, however, is a complementary mechanism to address climate change, which enables the aviation sector to continue to grow post-pandemic.

5.2 Strengths of the model

The vast number of ratings and rankings hinder the efficient and standardized sustainability reporting of the airlines. The AHP method, in conjunction with the intuitionistic variables, permits a holistic approach whereby airlines’ ESG performance can be determined in a relatively more straightforward and standardized manner (Németh et al., 2019). The model

Table 14 Global weights of KPIs

Global rank	Key performance indicators	Global weights
1	Number of accidents	0.173
2	Total jet fuel consumed (tonnes) and the percentage of sustainable aviation fuel used	0.076
3	Number of digital transformation initiatives fully implemented	0.072
4	Number of impacted flights	0.068
5	Total retired aircraft from operational service and percentage of re-used parts and recycled materials	0.066
6	Number and duration of strikes and lockouts	0.048
7	Gross global Scope 2 emissions (metric tonnes CO ₂ -e)	0.048
8	Gross global Scope 1 emissions (metric tonnes CO ₂ -e) and emissions per passenger	0.047
9	Total amount of legal and regulatory fines	0.045
10	Number of governmental enforcement actions of aviation safety regulations	0.044
11	Total number of aircraft propelled by both fuel and an electric battery	0.042
12	Number of restricted destinations	0.039
13	Number of social initiatives and charity donations	0.036
14	Percentage of gender and racial/ethnic group for managerial and technical staff	0.035
15	Employee turnover rate	0.032
16	Number of parked aircraft / Aircraft on Ground	0.032
17	Total air emissions of pollutants NO _x , SO _x , and particulate matter (metric ton CO ₂ -e)	0.030
18	Percentage of aircraft that meet or exceed – 10 dB criterium	0.028
19	Levels of employee engagement	0.022
20	Total airline carbon offset and percentage of voluntary passenger carbon offset	0.017
Total		1.000

Table 15 Breakdown of consistency ratios and group consensus

Hierarchy level	Node	CR (%)	Group consensus (%)	Group consensus category
1	ESG main criteria	0.9	66	Moderate
2	GHG emissions	2.2	71.4	Moderate
2	Environmental opportunities	1.2	74.6	Moderate
2	Labor practices	0.0	63.1	Low
2	Employee engagement, diversity and inclusion	0.0	69.3	Moderate
2	Critical risk management	0.0	56.1	Low
2	Systemic risk management	0.6	68.4	Moderate

Table 16 Rating ESG performance of alternatives

Key performance indicators	AIRLINE 01			AIRLINE 02		
	GW	Variables		Variables	IFN	GW×IFN
Number of accidents	0.173	EL	0.98	EL	0.98	0.169
Total jet fuel consumed (tonnes) and the percentage of sustainable aviation fuel used	0.076	VH	0.15	VH	0.15	0.011
Number of digital transformation initiatives fully implemented	0.072	VP	0.15	VG	0.75	0.054
Number of impacted flights	0.068	H	0.25	VL	0.75	0.051
Total retired aircraft from operational service and percentage of re-used parts and recycled materials	0.066	M	0.35	L	0.55	0.036
Number and duration of strikes and lockouts	0.048	EL	0.98	M	0.35	0.017
Gross global Scope 2 emissions (metric tonnes CO2-e)	0.048	H	0.25	VH	0.15	0.007
Gross global Scope 1 emissions (metric tonnes CO2-e) and emissions per passenger	0.047	VH	0.15	H	0.25	0.012
Total amount of legal and regulatory fines	0.045	VL	0.75	M	0.35	0.016
Number of governmental enforcement actions of aviation safety regulations	0.044	EL	0.98	VL	0.75	0.033
Total number of aircraft propelled by both fuel and an electric battery	0.042	P	0.35	VG	0.75	0.032
Number of restricted destinations	0.039	EH	0.02	L	0.55	0.022
Number of social initiatives and charity donations	0.036	VG	0.75	VP	0.15	0.005
Percentage of gender and racial/ethnic group for managerial and technical staff	0.035	M	0.50	G	0.65	0.023
Employee turnover rate	0.032	L	0.55	M	0.35	0.011
Number of parked aircraft/Aircraft on Ground	0.032	VH	0.15	VL	0.75	0.024
Total air emissions of pollutants NOx, SOx, and particulate matter (metric ton CO2-e)	0.030	H	0.25	H	0.25	0.007
Percentage of aircraft that meet or exceed – 10 dB criterion	0.028	EX	0.98	P	0.35	0.010
Levels of employee engagement	0.022	M	0.50	M	0.50	0.011
Total airline carbon offset and percentage of voluntary passenger carbon offset	0.017	EL	0.02	EX	0.98	0.017
Total	1.000					0.568

ensures that stakeholder judgments are considered and provides transparency during the whole process. The proposed AHP model allows the identification of indicators with low performance. Consequently, companies can address the indicators immediately and perform a comparative analysis and ranking of KPIs without compromising the robustness of the model. Moreover, it can be replicated in similar processes, thereby reducing costs and effort related to the selection process (Mohammed Bahurmoz, 2020).

The addition of intuitionistic variables allows categorizing the performance of the airlines' KPIs. The flexibility of the fuzzy theory enables benchmarking with other companies or with a specific target through simplistic terms for a general audience. Furthermore, the fuzzy coefficients generate a comprehensive process along with the global weights from the AHP method.

6 Conclusion

6.1 Results and critical reflections

This study proposes a comprehensive AHP model with intuitionistic variables to calculate the ESG performance of the airlines. The paper delimits a set of key performance indicators according to the issues and opportunities in the aviation sector. Additionally, the research determined appropriate weights based on the responses of aviation and ESG professionals.

By conforming to the proposed model, the results demonstrated that airlines with a strong focus on safety, risk management, GHG emissions, and environmental opportunities would obtain a higher ESG performance. Similarly, companies addressing digitalization and sustainable aviation fuel should perform more competently in the evaluations. On the other hand, the study determined that the carbon offsetting scheme represents the lower priority.

Further research findings are the lack of standardization in the sustainability reports from the airlines and the lack of transparency among the rating agencies.

6.2 Limitations and further research

The limitations of this study are related to the scope of the survey participants. The primary focus was the European airlines, limiting the validity of the results to the respective region. Additionally, the AHP model excels with a small number of criteria. However, the method obtains a higher degree of complexity when more indicators are added to the problem. Powerful software and effort from all the survey participants would be required in this scenario.

For further research, the ESG KPIs should be examined by the airlines and ESG analysts to validate this set of indicators for future theoretical and practical work. Moreover, the high weight of digital initiatives in this study presents an opportunity to address the correlation of sustainability and digital transformation.

6.3 Summary of implications

This study presents a novel approach in identifying, weighting, and ranking the ESG criteria and the most suitable KPIs in the airline industry. This approach addresses the industry's sustainability challenges, particularly in airlines, which would be valuable for academics, practitioners, and policymakers. Furthermore, the results of this paper are applicable to practice. The recent United Nations Climate Change Conference (COP26) exposed the necessity of addressing the environmental initiatives represented in this research. These initiatives have positive to firm value, as explored by Qureshi et al. (2020) and Xie et al. (2019).

The paper's findings can also enhance the airline industry's sustainability and resilience after COVID-19 impact. By focusing on ESG KPIs, airline practitioners and policymakers can better prepare for future disruptions and demonstrate their commitment to long-term sustainability. On the other hand, the proposed model could be replicated by the airlines and benchmark their results with their competitors and improve their ESG performance as airlines with higher ESG ratings could gain a competitive advantage in the post-COVID-19 recovery phase. This is in line with the previous research results from Abdi et al. (2020, 2021) and Kuo et al. (2021) that it brings more returns on invested funds in terms of company financial performance.

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