



Airports' Sustainability Strategy: Evaluation Framework Upon Environmental Awareness

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Global sustainability challenges are reshaping how businesses operate in the 21st century. The necessary condition of ensuring economic, social, and environmental sustainability, also affects the functioning of regulatory authorities and businesses, particularly in the air transport sector, which, by facilitating access to productive services and connectivity to markets, is a critical contributor to the economy. Businesses are increasingly being pressed by decision makers (e.g., stakeholders, shareholders, customers, employees, and society) to assess their socioeconomic impacts and manage their actions sustainably and resiliently. As a result, effective management is a top priority not only for airport operators and authorities, but also for the national and local economies in this competitive and economically sensitive environment. The purpose of this article is to present an assessment tool for evaluating airport strategic plans and environmental reports, and address how corporate actions can promote sustainability in the frame of environmental awareness in operating large transport hubs. The assessment methodology is based on a comparative analysis between airports and regulatory authorities' threshold. The role of sustainability in the air transport business ecosystem is depicted, demonstrating that its relationship to business performance is a significant barrier to business resilience and competition for planners, managers, and decision makers. The numerical application considers a group of 10 European International airports delivering international flights and business. Conventional wisdom is to provide the evaluation analysis framework for planning and managing capital-intensive transport hubs such as airports.

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INTRODUCTION

In today's corporate ecosystem, where economic and social activities are oriented on transformation in order to attain prosperity and resilience, the concept of sustainability is crucial. Global sustainability issues are also having an impact on how firms operate in the twenty-first century. The necessary condition, ensuring economic, social, and environmental sustainability, has an impact on the functioning of regulatory authorities and businesses, particularly in the air transport sector, which is a major contributor to the economy, particularly in remote destinations like Greece, by promoting access to productive services and market connectivity. Businesses are increasingly under pressure from decision makers (e.g., shareholders, consumers, employees, and society) to

examine their socioeconomic implications and manage their actions with a long-term and resilient mindset (United Nations (UN), 2016). In this competitive and economically sensitive climate, good management is a primary responsibility not just for airport operators and authorities, but also for national and local economies.

The link between environmental awareness and the business ecosystem is critical and taking the right steps to establish a healthy balance between these two pillars can help businesses run more efficiently. Environmental performance evaluation of important facilities, such as airports, is critical in this setting for maintaining business resiliency and sustainability. Air pollution, noise, water and soil pollution, litter, and biodiversity loss can all be detrimental outcomes of an airport's operation and development. Airport operations' environmental effects have the ability to limit operational capacity and future growth potential, according to the European Environment Agency (2019), particularly when these factors outrun regulatory frameworks' bounds, planning arrangements, or local communities' forbearance, but also in case that surrounding areas suffer from water scarcity or lack of energy reserves. As a result, airport operators will face a difficulty in balancing the economic and social benefits of an airport's operations with the environmental and human health impacts (Dimitriou and Sartzetaki, 2018).

This article deals with the development of an assessment tool to evaluate airports strategic plans in terms of their environmental performance and address how corporate actions can promote sustainability in the frame of environmental awareness in operating large transport hubs. The primary goal of this study is to examine airport environmental plans and reports, evaluate their applied environmental management plans and processes, identify the main aspects of the sustainable airport management, and suggest future research possibilities. In the numerical application, a group of airports having similar air traffic patterns with Greece is taken into consideration. The main goal is to provide a framework for evaluating and managing capital-intensive transport hubs such as airports.

THEORETICAL BACKGROUND

Air Transport Contribution to EU Economic Development

In 2016, transportation accounted for around 5% of the EU's gross value added and 5.2% (or approximately 11 million people) of created jobs, making it a vital sector of the EU economy. It has a direct impact on all EU residents' daily lives, ensuring the flow of goods from over 11 million EU producers and manufacturers to consumers (Dimitriou, 2016). As a result, effective transportation systems have become a cornerstone of European integration. The completion and successful operation of the European Union require well-planned, sustainable, and completely integrated transportation networks. The expansion of the EU's transportation infrastructure will demand a substantial financial investment. Total investment needs in this field are anticipated to be over €130 billion each year, according to the European Commission, with additional major

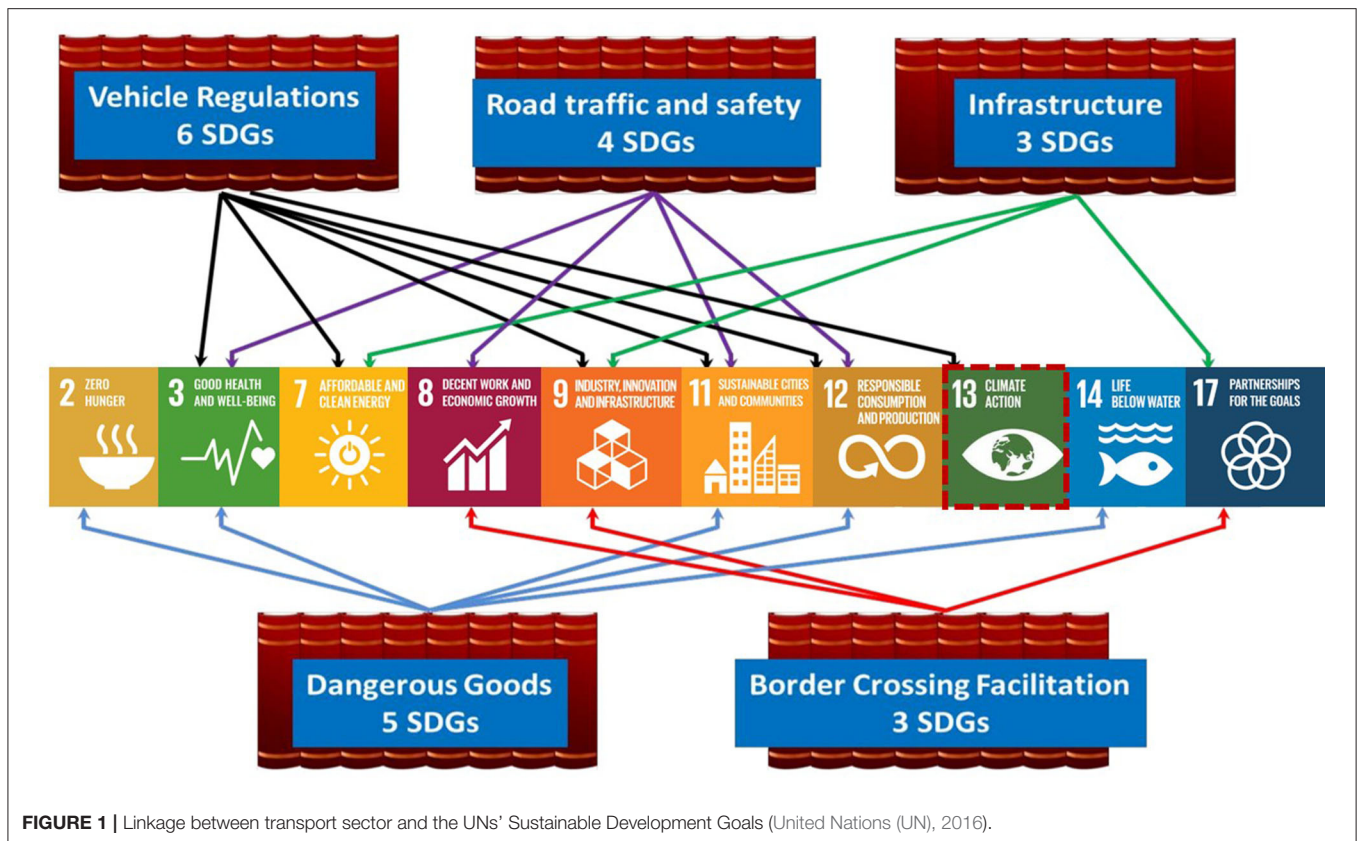
investment required for maintenance. A successful development of intelligent management systems in transport sector is required in order to achieve coherent, efficient, co-modal transport networks across the European region. Furthermore, automation, digitalization, and shared mobility are fast-growing innovations that have the potential to increase transportation system efficiency. New technology and movement patterns, on the other hand, provide new issues in terms of legislative framework suitability, data security, privacy protection, safety, and responsibility.

Air transport infrastructure and provided services must be efficient in order to capitalize on the EU region's economic capabilities, strengthen markets' interaction, promote growth, and enhance social cohesion across the region. Because of its critical role, air transport sector is inextricably linked to policy aspects such as its environmental impacts determination, job creation, competitiveness enhancement and strengthening social policies. Additional problems include infrastructure adaptation to transport sector's sustainable transition and the development of new infrastructure that could support the use of clean fuels, both of which demand new investment and a rethinking of network and business model design. The rise of electromobility, particularly the use of electric vehicles, necessitates the construction of charging infrastructure. The EU began its clean fuels policy in 2013, with the goal of creating a uniform network of alternative fuel stations (including EV charge points).

Airports have been demonstrated to play a vital impact in economic development in numerous studies. Airports provide enormous social advantages and are often regarded as most significant source of revenue in the areas they serve (Air Transport Action Group, 2018). In addition, numerous studies show that the development of airports and the provision of air services could lead to a region's social and economic development, by reducing unemployment and increasing its productivity, thus the income of the local community (Dimitriou, 2016). Airports' economic benefits are evaluated in terms of direct employment, investments attracted and tourism, international trade, cultural development, and educational and recreational travel (Industry High Level Group, 2019; Air Transport Action Group, 2020). The sum of an airport's direct, indirect, induced, and catalytic effects on a region determines its economic impact (Graham, 2013). While airports have become important development challenges in many areas, negative environmental and community consequences are issues that are directly tied to future airport growth.

Air Transport and Sustainable Development Linkage

Transport is critical for a region's development because it connects people and local communities to the rest of the globe, creates marketplaces, and facilitates trade (United Nations (UN), 2016). As a result, sustainable transportation can help to drive sustainable development. Sustainable transportation is defined as the provision of services and infrastructure for transporting people and goods in a safe, efficient and affordable way, while

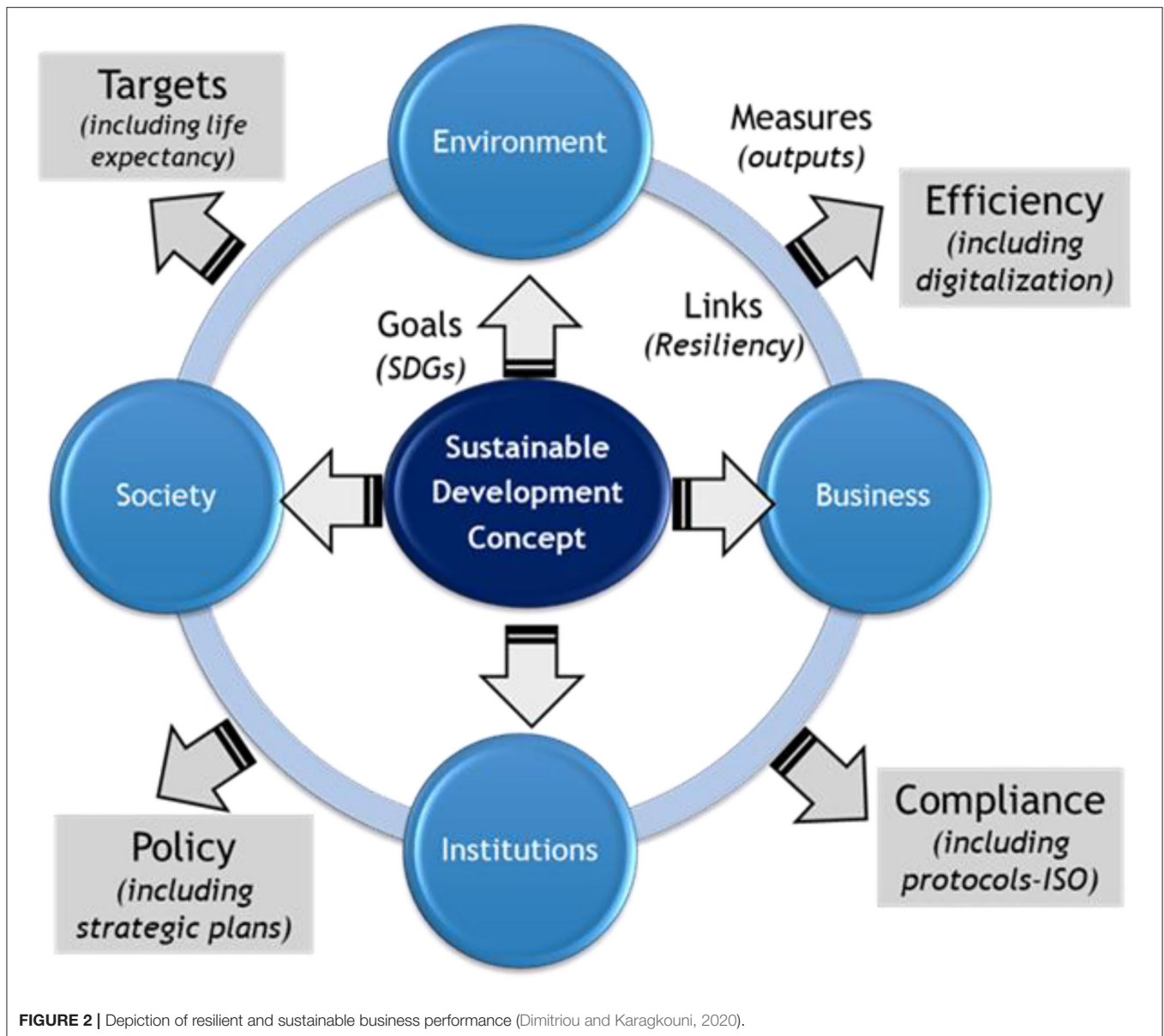


minimizing emissions (e.g., carbon) and its environmental impacts for present and future generations (United Nations (UN), 2016). However, not all objectives may be satisfied simultaneously. It is impossible to overestimate the relevance of industrial priorities in attaining sustainability. For example, a balance must be struck between actions to minimize air transport emissions and those made to accommodate the sector's ever-increasing demand. The challenges are tremendous, but so are the potential for innovative decisions in the field of transportation now and in the coming years, in both developed and developing countries, to put cities and nations on a sustainable development path. Ambitious goals, targets, and indicators will form this journey. Progress must be tracked and reviewed, with course modifications made as needed. The 17 Sustainable Development Goals are the guideposts for the 2030 Agenda for Sustainable Development, which outlines a road to more universal sustainable development (SDGs) (Figure 1).

Effective planning in transport sector considers the social, economic, and environmental aspects of transportation, as well as overall development, while balancing the need for short-term deliverables with a long-term strategic perspective (Dimitriou and Sartzetaki, 2018). While it is common sense to address both short- and long-term demands in all planning, it is especially crucial in transportation because of the complex nature of the industry and the resource-intensive nature of many transports infrastructure. With longer time horizons, the business rationale

for sustainable development becomes more evident. Investing in renewable energy or resilient infrastructure, for example, will help businesses save and gain money in the long run (Dimitriou and Voskaki, 2010). Competition is a tremendous driving factor for private sector enterprises and, as previously said, local and national governments, and competing to become more sustainable will pay off for companies, governments, and the globe at large in the long term (Dimitriou and Sartzetaki, 2019). In order to achieve sustainable transport development, resilient planning is crucial, as it ensures that transport networks can effectively adapt to climate change-related unexpected events, chronic stresses and intensive shocks.

Mega infrastructure projects, such as airports, are usually planned with a long-term perspective in mind, necessitating the inclusion of suitable infrastructure facilities from the start to ensure the project's long-term viability (Airport Council International Policy Brief, 2018). With these preventive efforts to protect facilities, airports are intended to be resilient against future climate change and extreme weather conditions. Figure 2 depicts the relationship between the major pillars that supports resilient and long-term business performance. The link between environmental awareness and the business ecosystem is critical and taking the right steps to establish a healthy balance between these two pillars can help businesses run more efficiently. Environmental performance evaluation of important facilities, such as airports,



is critical in this setting for maintaining business resiliency and sustainability.

Airports' Environmental Performance

While aviation has substantial financial benefits, it also has significant environmental implications on both local and global scale. Climate change is the principal issue that regulators face on a global basis. While noise is considering as the main issue at the local level over the last 20 years, air emissions, water and energy availability, and waste management are also issues that are directly related to the forbearance of the local communities, as the negative environmental impacts of aviation can lead to restrictions on existing airport operations and future growth constraints; the adverse environmental and community impacts of aviation could impede airports' efficient operation

and prevent their future growth (European Environment Agency, 2019). Environmental plans and sustainability reports from airport operators' analysis discovered that airport environmental management is primarily concerned with the environmental consequences that may act as operational limits, and the ways these impacts are identified, assessed, and controlled (Graham, 2013). In the following paragraphs, the main environmental impacts are briefly discussed.

Emissions

The most significant sources of emissions at airports include vehicles, operating both in airport's airside and landside, ground support equipment and electricity generation facilities (Cokorilo, 2016). Despite the fact that airports are frequently the most major source of air pollution in a community, the expansion of air

travel has substantial climate change consequences for the global environment. Nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter, sulfur oxide, and carbon dioxide (CO₂) are all contaminants that affect air quality (Dimitriou et al., 2014; Postorino and Mantecchini, 2014). Despite accounting for only about 2–3% of anthropogenic CO₂ emissions, CO₂ emissions from aviation are increasing year after year because the industry's growth is outpacing the rate of airframe and engine development (Cokorilo, 2016). Several factors influence local air quality in the vicinity of airports. In general, the primary goal of local air quality and emissions management is to achieve and maintain compliance with local pollutant concentration restrictions (Dimitriou et al., 2019; Grewe et al., 2021).

Noise

The most significant local impact affecting communities near airports appears to be noise (Alonso et al., 2017). Noise has a substantial impact on people's health and quality of life, can detract from the allure of destinations, and can generate hostility from locals. The single most critical issue influencing the operation and expansion of airports—and consequently their capacity—is frequently aircraft noise nuisance at the local level (Dimitriou and Voskaki, 2010; Asensio et al., 2017). Rapid expansion in air travel has stifled technological improvements. As a result, most major airports are now subject to operational restrictions or capacity limitations based on aircraft noise data (Rodríguez-Díaz et al., 2017). Approximately two-thirds of airports in Europe are now subject to noise restrictions or have their operations hampered indirectly by noise-related concerns, with this proportion predicted to climb to 80% in the next 5–10 years (Dimitriou et al., 2014; Greer et al., 2020).

Energy Management

Airport infrastructure necessitate a significant quantity of electricity. Heating, ventilation, air conditioning, and lighting account for the majority of energy use at airports (Alba and Mañana, 2016; International Civil Aviation Organization, 2017). Improvements in airport energy efficiency or the utilization of renewable energy sources result in significant cost savings as well as in carbon footprint reduction. Wind and solar energy costs have decreased significantly in recent years, according to IRENA (International Renewable Energy Agency, 2016), and are expected to decline by 59% by 2025. Airport operators often invest in sources of renewable energy to save money. Green energy options for airports emphasize energy efficiency and renewable energy technology. The airport's energy needs can be met by wind, biomass, hydropower, solar PV, and geothermal heat pumps (Yerel Kandemir and Yayli, 2016; Baxter et al., 2019b; Clean Energy Finance Corporation (CEFC), 2020). To maintain independence from local grids, microgrid technology can be used to install solar thermal collectors on existing airport facilities.

Water Management

Airport development and operation necessitates the use of water resources, especially in areas where water resources are scarce. Several airports, particularly those in the Mediterranean region, are already dealing with water availability issues. However, water

availability was seen as a potential long-term limitation even at Heathrow Airport (Baxter et al., 2019a). According to De Castro Carvalho et al. (2013), surface water discharges, de-icing and anti-icing fluids, chemicals, fuel spillages, and, of course, sewage water from buildings are some of the most common sources of water pollution at airports (Dimitriou et al., 2014; International Civil Aviation Organization, 2019).

Waste Management

Airport operations generate a significant amount of waste, which must be managed in accordance with the 'polluter pays' principle. Waste generation includes all operational and maintenance activities by the airport operator, airlines and any other entity operating in the airport facilities. The majority of waste produced consists of solid urban waste, hazardous and non-hazardous waste from airfield operations, aircraft catering facilities and terminal operations and maintenance (International Civil Aviation Organization, 2018; Clean Energy Finance Corporation (CEFC), 2020). Moreover, the amount of generated waste is determined by the number of passengers and employees in the airport facilities. Even though airlines generate the majority of waste, airport operators manage it in most cases (International Civil Aviation Organization, 2017; Baxter et al., 2018).

Ecosystems

In airport development, main infrastructure such as runways, taxiways, aprons, and terminal buildings, as well as ancillary infrastructure such as roads and trains, must be built on enormous swaths of land (Greer et al., 2020; Grewe et al., 2021). This has an impact on local ecosystems and has the potential to degrade their functions and lead to biodiversity loss.

According to Graham (2013), environmental impacts and issues differ in airports, depending on the public sector's involvement and the existence of a regulatory framework and other social issues. Air transport sector, like many industries, has to manage the effects of the rising environmental pressure. Although the environmental issues that most airports are facing have a direct impact on their growth in both local and global level, their importance will be determined by current operations and the need for additional infrastructure. As a result, adopting the appropriate policies and measures for maintaining a balance between airports' operation economic and social benefits and potential costs arising from their environmental impacts, are key parts of effective planning and management in transport sector (Dimitriou and Sartzetaki, 2019).

A variety of airports have previously released and published sustainability reports and environmental plans that include environmental protection policies, carbon neutrality goals, and investment plans. Furthermore, some airports have advanced and have also implemented measures and actions related to supply chain management, in order to address product-related environmental issues. Moreover, airports of smaller size, present their environmental policies without specifying any precise environmental performance target or related quantified data. The importance of identifying all environmental hazards associated to airport operations is generally acknowledged. However, a

series of airports continue to assess their performance based only on operational, and financial data (Dimitriou and Voskaki, 2010). Despite the fact that environmental issues appear to be important for most airports' development, many airport policies are mainly focused on attracting and increasing demand for new routes and destinations, rather than investing in dealing with the environmental impacts of their current operations. While environmental issues seem to be crucial for airport development, few airports develop a coherent and effective environmental strategy in place aimed at reducing the overall environmental impact of their operations.

METHODOLOGY FRAMEWORK

In general, the evaluation method and the selected application are crucial for identifying the proper methodology framework. Benchmarking provides significant benefits to illustrate results when comparing similar industry units on the same business (Adler et al., 2013). The main goals of the methodology presented in this article are:

- To provide a comparative framework between airports with similar traffic patterns;
- To provide a useful tool to managers and stakeholders in the transport sector for evaluating airports' environmental performance; and
- To enhance decision-making mechanisms in order to build and present an effective strategy for long-term sustainability;

Controlling the environmental impacts that result from an airport's operation presupposes the involvement of many stakeholders in the decision-making process. Within the airport's boundaries, the airport operator, regulatory and aviation authorities are in charge of the operations that may cause an environmental disturbance. Outside the airport territory, in addition to the airport operator, local, regional, or even national authorities have decision-making authority, based on the fact that minimizing air transport infrastructures' environmental impacts could have multiple benefits in a local or regional level.

It is stated in this research that the airports' environmental management evaluation includes only actions and decisions that are directly linked to the airport operator. These actions are included in four (4) distinguished categories (evaluation criteria) that are directly linked to the framework of circular economy, which are emissions, noise, water and waste-ecosystems (Dimitriou et al., 2014).

The evaluation sub-criteria include, among others, emissions, noise, and water quality monitoring, resource consumption, the existence of anti-noise and energy-efficient infrastructure, and waste (solid, liquid and hazardous) management. Other mitigating or compensatory strategies are also mentioned, such as GHG reduction targets, recycling, and waste pricing policies and incentives (Table 1). Although there is some information in the literature about the different types and categories of airport environmental impacts, it is worth emphasizing that there is limited focused study on the importance of each category (criterion). The importance of the selected criteria in

TABLE 1 | Environmental performance evaluation criteria.

Emissions (E)	Noise (N)
Emissions monitoring	Noise action plan
GHG emissions reduction target	Air traffic management
Carbon footprint	Noise monitoring
Energy-efficient infrastructure	Anti-noise infrastructure
Renewable electric power	Registration of noise complaints
Water (W)	Waste-Ecosystems (WE)
Water conservation system	Recycling
Water quality monitoring	Hazardous waste management
Water runoffs management	Waste minimization measures
Water consumption monitoring	Waste pricing policy
Wastewater treatment	Protection of biodiversity

TABLE 2 | Evaluation criteria importance multipliers.

Evaluation criteria	Importance multipliers	
	Code	Value
Emissions (E)	a	0.40
Noise (N)	b	0.30
Water (W)	c	0.15
Waste-Ecosystem (WE)	d	0.15
Sum		1.00

the evaluation is based on the adjustment of the importance of each category to aviation development (Dimitriou et al., 2014). According to the literature (Sartzetaki, 2019), climate change is recognized as the most critical issue in terms of its impacts on the aviation sector's development, and it is at the top of the agenda in terms of airport sustainable development (Dimitriou et al., 2019). Because of its impacts on the local communities' health and well-being, air quality and noise are also considered as major issues. Local scale environmental disruptions are also linked to water, waste, and ecosystem management; however, complaints differ depending on the cultural background and environmental sensitivity of the local communities. Consequently, according to Dimitriou et al. (2014), the following importance multipliers (Table 2), have adopted, based on the evaluation criteria impact on airports, to represent the importance of each criterion in the evaluation process.

The environmental management performance score (EMP) for the airport sample is given by the following equation:

$$EMP = aE + bN + cW + dWE = 0 \tag{1}$$

Where:

E = number of sub-criteria succeeded in environmental plans in category of emissions.

N = number of sub-criteria succeeded in environmental plans in category of noise.

W = number of sub-criteria succeeded in environmental plans in category of water.

WE = number of sub-criteria succeeded in environmental plans in category of waste ecosystems.

a,b,c,d = importance multipliers.

APPLICATION

It is commonly understood that identifying the many factors that may lead to an efficient environmental management system is crucial. Although the Global Reporting Initiative (GRI) established a framework for sustainability reporting in the aviation industry, not all airport operators follow these rules when publishing their sustainability reports (Karaman et al., 2018; Kiliç et al., 2019). While sustainability reporting increased over the last few years, the majority of the used frameworks result in incorrect measurement, by not covering many environmental aspects that concern the sector.

A review of the performance literature (United Nations Economic Commission for Europe, 2017; Dimitriou and Sartzetaki, 2018) provides some useful insights into the difficulty of establishing a link between more understandable aspects, such as financial performance and less processed aspects, such as environmental management performance. Many times, these difficulties are directly linked to different business plans, and strategies, while in others, accurate measurements to reflect a direct comparison system have proven difficult to demonstrate. In general, the need to measure performance in industry management is directly related to decision-making processes centered on supply chain activities. The key goal of performance evaluation is to assess efficiency and develop effective plans, while including all relevant stakeholders in the decision-making process (Dimitriou and Karagkouni, 2020; Greer et al., 2020).

According to the literature, there has been limited research into evaluating airports' environmental performance and implementing comprehensive strategies to ensure their sustainable transition (Dimitriou and Voskaki, 2010). In this study, a holistic approach to evaluating airport operators' environmental management strategy is presented, based on

the concept of sustainable development. The sample consists of European airports, as they have comparable characteristics, operating under a common regulatory framework. The airports in the sample were chosen based on their geographical distribution and traffic patterns that are similar to those of Greece. The key facts about the airport sample are presented in **Table 3**.

The review of airports' environmental reports and plans resulted in the identification of different ways of reporting about airports' various efforts for their environmental impacts minimization. More specifically, some aspects were handled and presented differently, and quantitative data was not presented in most cases. Furthermore, while most airports apply an Environmental Management System (EMS) like EN-ISO 14001, indicating that they prioritize environmental risks mitigation and the need of taking measures to control and mitigate their environmental impacts, there is a lack of quantified information and specific measure and targets regarding their environmental performance (Dimitriou et al., 2014). Also, airports typically use a range of measuring units and changeable data, as well as reporting in a number of timeframes. As a result, a qualitative approach was required to assess airports' environmental management performance.

EVALUATION RESULTS

Table 4 presents the EMP scores for the selected airport sample based on data and information from the airports' environmental reports and plans that have been reviewed. Despite the fact that airports acknowledge the environmental impacts caused by their economic and operational activities, a few of them have implemented appropriate mitigation measures, according to **Table 4**. As a result, none of the airports in the sample met all of the evaluation criteria. Athens International Airport (ATH) and London Stansted Airport (STN) seem to have the highest performance, while Düsseldorf Airport (DUS) presents the lowest performance in the sample. In most of the evaluated environmental management categories (criteria), most airports seem to apply a precise environmental strategy to meet certain

TABLE 3 | European Airports' key facts.

Airports	IATA code	Operator	Pax 2019 (million)	Environmental plan/report (2019)
Copenhagen Airport	CPH	Copenhagen Airports	30.26	Yes
Palma de Mallorca Airport	PMI	Aena	29.72	Yes
Malpensa Airport	MLP	SEA Aeroporti di Milano	28.85	Yes
Oslo Airport	OSL	Avinor	28.59	Yes
London Stansted Airport	STN	Stansted Airport Limited	28.12	Yes
Brussels Airport	BRU	Brussels Airport Company	26.36	Yes
Stockholm Arlanda Airport	ARN	Swedavia	25.64	Yes
Athens International Airport	ATH	Athens Int. Airport S.A.	25.57	Yes
Düsseldorf Airport	DUS	Flughafen Düsseldorf GmbH	25.51	Yes
Helsinki Airport	HEL	Finavia	21.86	Yes

Airports operators' official websites (Accessed: May 2020).

TABLE 4 | Airports' environmental management performance scores.

Evaluation criteria	Environmental management performance score (EMP)									
	ATH	BRU	ARN	MPX	OSL	STN	HEL	PMI	DUS	CPH
E	2.0	1.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
N	1.2	1.2	0.9	0.9	0.9	1.5	0.9	0.9	0.6	0.9
W	0.6	0.3	0.5	0.5	0.5	0.6	0.6	0.5	0.3	0.6
WE	0.8	0.6	0.3	0.5	0.5	0.6	0.6	0.8	0.3	0.3
Sum	4.6	3.7	3.7	3.8	3.8	4.7	4.1	4.1	3.2	3.8

Airports' environmental plans/reports (2019).

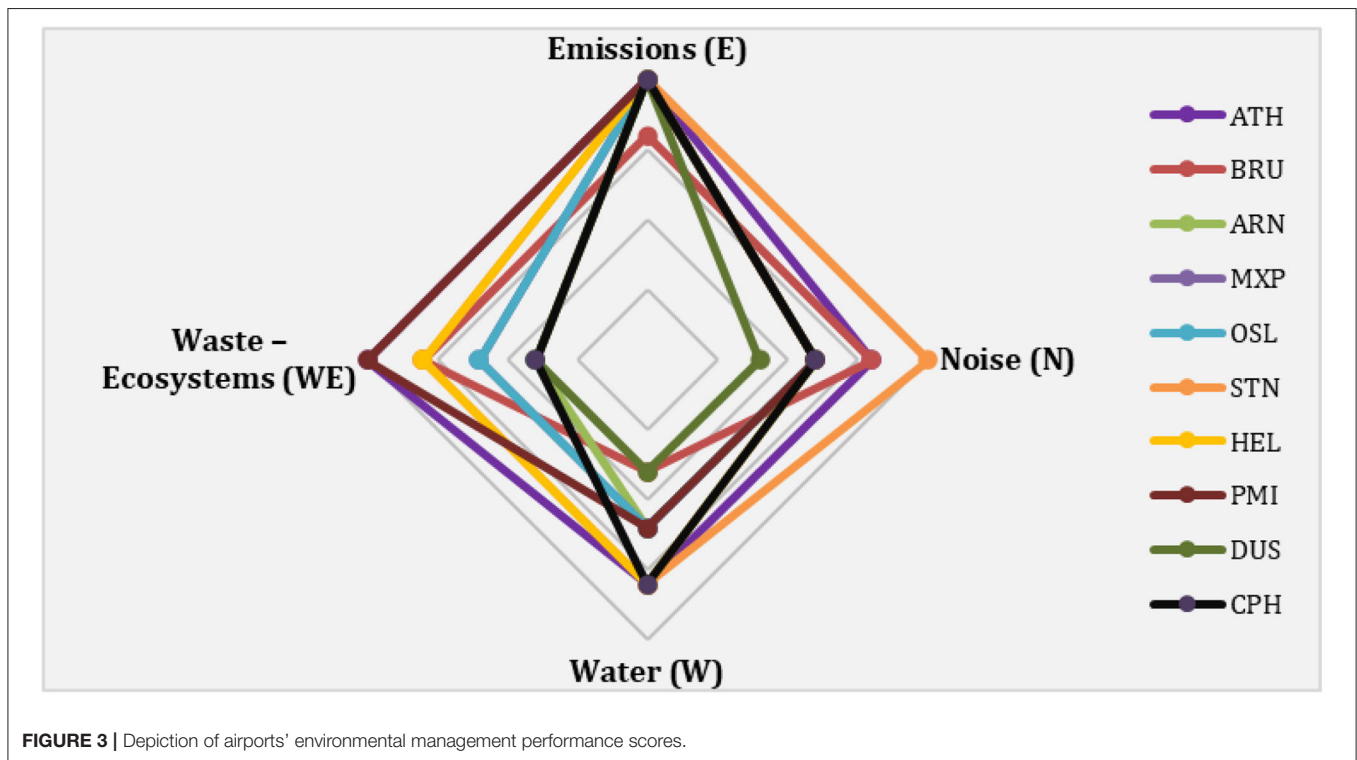


FIGURE 3 | Depiction of airports' environmental management performance scores.

targets. Depiction of airports' performance based on each evaluation criterion is presented in **Figure 3**.

In all evaluation categories, over 70% of the sample presents score above average, in category of emissions, the vast majority of the sample presents the highest score. Consequently, the most critical issues appear to be emissions and noise management, as most airports in the sample include 5 out of 5 emissions-related as well as noise-related sub-criteria in their environmental strategy to accomplish goals and meet specific targets. Water management, on the other hand, is regarded as the least critical issue, as three out of five relevant sub criteria for meeting particular goals are included. Also, it is worth noting that the airports in the sample take steps to mitigate or compensate for environmental impacts, particularly when it comes to airports that serve a regional function. In the vast majority of cases, the future importance of specific environmental concerns is also taken into account. For example, the industry recognizes climate

change as one of the major present restrictions, and in most cases, the applied environmental management strategy is altered to include not only measures and actions related to carbon management, but also to support targets related to the sector's long-term environmental performance.

The reviewed airport sample's environmental strategy appears to be dependent on the airport's location. Airports in regions with strict environmental policies have recognized all factors of achieving carbon neutrality and are concentrating their efforts on renewable energy, lowering carbon-related energy use, and supporting the use of biofuels. Airports in tourist regions, on the other hand, concentrate their efforts on noise mitigation rather than GHG emission reduction. An exception is Athens International Airport (ATH), which serves a major European tourist destination and seems to set innovative goals linked to most of the evaluation sub criteria. Furthermore, airports located in water-stressed areas appear to prioritize water management

initiatives, such as monitoring their water consumption, implementing specific water conservation measures, encouraging water re-use, managing runoff, and monitoring surface and groundwater quality.

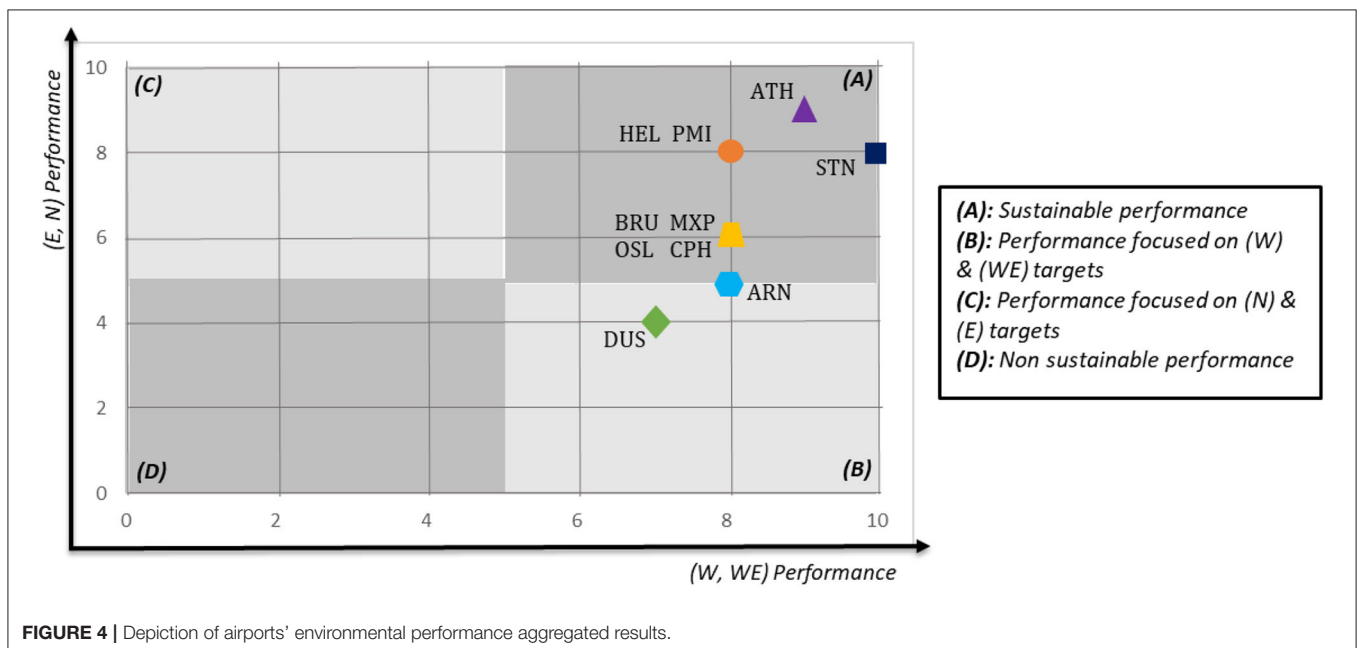
The identification of an effective environmental management strategy that should be addressed by an airport operator is directly linked to maintaining a balanced approach between emissions and noise-related operational disruptions mitigation and dealing with the environmental impacts that affect the local communities, such as water and waste management, as well as ecosystem protection. The environmental performance of airports in terms of managing these two primary objectives, emissions-noise (E-N) and water-waste-ecosystems (W-WE), was taken into account in order to evaluate the balance between them. In this context, based on airports' performance in emissions and noise mitigation (E, N) in one hand, and in locally oriented environmental impacts (W, WE) on the other hand, four (4) sections could be developed, as shown in **Figure 4**.

According to the evaluation results, most of the sample's airports appear to follow a balanced development model in managing the two main evaluation categories mentioned above. Especially Athens International Airport (ATH) and London Stansted Airport (STN) present the highest performance, setting and achieving specific goals regarding all evaluation criteria. Moreover, Stockholm Arlanda Airport (ARN) and Düsseldorf Airport (DUS) appear to follow a strategy directed mostly to Water (W) and Waste-Ecosystems (WE) targets, not taking many measures regarding emissions reduction and noise disturbance control. Finally, it is noteworthy that none of the airports in the sample is placed in section "D", which means that they prioritize environmental sustainability goals and try to promote sustainable transition strategies.

CONCLUSIONS

The necessity of assuring economic, social, and environmental effect mitigation impacts regulatory authorities, organizations, and enterprises, particularly in the air transport industry, which facilitates access to productive services and market linkages. Stakeholders, shareholders, consumers, employees, and society are increasingly pressuring businesses to examine their socioeconomic consequences and manage them sustainably and resiliently (Alba and Mañana, 2016; Dimitriou and Sartzetaki, 2019; Greer et al., 2020). The aviation industry's sustainability planning process relies on evaluating the effectiveness of environmental mitigation strategies and the efficiency of mitigation actions delivered or approved by airlines and airports.

In this article, the development of an assessment tool to evaluate airports strategic plans and reports in terms of their environmental performance and awareness is highlighted. The analysis of the airport sample's reviewed environmental plans and reports revealed that the majority of the selected airports follow a distinct environmental strategy. Despite the fact that airports are aware that their business and operational activities have environmental repercussions, not all of them seem to implement effective mitigation measures. Moreover, the significance of specific environmental challenges in the future is taken into account in the majority of cases. For example, the sector recognizes climate change as one of the major current issues, and in most cases, the airport's applied environmental strategy has been adapted to include not only measures and actions focused on carbon management, but also to support the sector's long-term sustainable transition (European Environment Agency, 2019; Grewe et al., 2021). Furthermore, the airport sample's reviewed



environmental strategy appears to be location dependent. Environmental challenges eventually have a direct impact on the global and local growth of the aviation sector, so airport authorities' and operators' planning process should be focused to the sustainable transition of air transport industry (Dimitriou and Sartzetaki, 2016).

The sample size could be a limitation of this study. A larger sample size could lead to more reliable and representative comparison results about airport environmental management. Findings promote key issues for effective air transport performance upon business resiliency and sustainable development, which is a major challenge for planners, managers and decision makers. Further research could focus on the development of a quantitative tool for assessing airports' environmental sustainability performance, by correlating environmental disturbance mitigation with operational (aircraft and passenger traffic), corporate performance (e.g., revenue passengers, commercial revenues etc.). In particular, the airport sustainable business development and structure should be examined in light of the ongoing trend of outsourcing various services (Dimitriou, 2021).

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DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

The methodology concept and evaluation framework driven by DD. The literature and the numerical application driven by AK. All authors contributed to the article and approved the submitted version.

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