Comparative Content Analysis of Airport Policies: Boston Logan International and Singapore Changi Airport

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ABSTRACT

As global aviation confronts the dual challenge of operational expansion and environmental sustainability, this study investigates how Boston Logan International Airport and Singapore Changi Airport institutionalize climate action through policy frameworks, comparing their strategies for carbon emissions reduction, ESG initiatives, and government social responsibility (GSR). Through comparative content analysis of sustainability reports, policy documents, and operational frameworks, the research identifies key divergences shaped by institutional contexts: Boston Logan's market-driven approach emphasizes aggressive short-term decarbonization (net-zero by 2031) and community engagement, while Changi's state-integrated model prioritizes Scope 3 emissions accountability and climate resilience under Singapore's Green Plan 2030. The findings underscore critical trade-offs between policy implementation speed and reporting rigor, highlighting the need for standardized sustainability metrics in aviation. By synthesizing best practices; from Changi's comprehensive emissions accounting to Boston Logan's electrification programs; this study provides a framework for context-responsive yet globally applicable sustainability policies. Ultimately, effective aviation climate action requires not only technological innovation but also stronger alignment between regional governance and international climate objectives.

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GRI	Global Reporting Initiative
ACI	Airports Council International
DE&I	Diversity, Equity, and Inclusion
ICAO	International Civil Aviation Organization
CAG	Changi Airport Group
SASB	Sustainability Accounting Standards Board
SAF	Sustainable Aviation Fuels
GHG	Greenhouse Gas
ESG	Environmental, Social, and Governance
GSR	Government Social Responsibility
PPPRC	Public-Private Partnership Resource Center
OAG	Official Airline Guide
ATAG	Air Transport Action Group
DNL	Day-Night Average Sound Level
AEDT	Aviation Environmental Design Tool
USGBC	U.S. Green Building Council
LEED	Leadership in Energy and Environmental Design
eVTOL	Electric Vertical Take-Off and Landing
IPCC	Intergovernmental Panel on Climate Change
SDGs	Sustainable Development Goals
MaaS	Mobility-as-a-Service
EMS	Environmental Management Systems
ISO	The International Standards Organization

MOT	Ministry of Transport, Connecting Singapore
ATAG	Air Transport Action Group
BRT	Bus Rapid Transit
UAM	Urban Air Mobility
AAM	Advanced Air Mobility
SBTi	Science Based Targets initiative
ASMF	Aviation Sustainability Metrics Framework
PSA	Partnership for Sustainable Aviation
CDP	Carbon Disclosure Project
TCFD	Task Force on Climate-related Financial Disclosures
IATA	International Air Transport Association
AEPC	Airport Environmental Protection Coalition
GAES	Global Airport Environmental Standards
EPI	Environmental Performance Index
ASA	Airport Sustainability Alliance
AEMS	Airport Environmental Management System
ACRP	Airport Cooperative Research Program
EU-ETS	EU Emissions Trading System
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EPA-AEP	Environmental Protection Agency's Airport Environmental Program
GSE	Ground Support Equipment
ASLO	Airport Social License to Operate
ISIAA	International Social Impact Assessment Association
ACEF	Airport Community Engagement Framework
AERC	Airport ESG Reporting Council

SAFI	Sustainable Aviation Finance Initiative
SAA	Smart Airports Alliance
IATC	International Airport Technology Consortium
ADTF	Airport Digital Transformation Framework
ACRAP	Airport Climate Risk Assessment Protocol
GACAN	Global Airport Climate Adaptation Network
UNDRR	United Nations Office for Disaster Risk Reduction
ARF	Airport Resilience Framework
SMSA	Standard Metropolitan Statistical Area
TNC	Transportation Network Company

CHAPTER 1 - INTRODUCTION

Frankfurt Airport's trial of cashew-based bio asphalt on a 200-meter-long section of road on the airport apron demonstrates a groundbreaking step towards sustainable airport operation (Galen 2024). Sustainability has become a cornerstone of environmental policy, particularly in industries with significant environmental impacts on their surroundings, such as aviation (Jordan and Lenschow 2009). Implementing innovative materials like bio asphalt highlights the crucial role of comprehensive planning in airport sustainability initiatives. Frankfurt Airport's sustainability policy framework, outlined in its 2030 Strategy, specifically emphasizes infrastructure innovation and carbon reduction, making it one of only three airports globally to experiment with bio-based pavements (Schäfer 2024).

This raises important questions about the variability in airport sustainability approaches, where factors such as geographic location, spatial configuration, and regulatory environments significantly influence implementation strategies. For instance, airports in tropical climates may prioritize different pavement technologies than those in temperate zones, while spatial constraints in urban areas may necessitate different approaches compared to airports with more expansive footprints. Airports, as critical nodes in global transportation networks, are responsible for substantial emissions and resource consumption, necessitating effective environmental strategies[1] (Greer, Rakas and Horvath 2020). This thesis focuses on environmental policies around sustainability initiatives[2] at two prominent airports: Boston Logan International Airport and Singapore Changi Airport. Specifically, it examines how these airports operationalize their sustainability policies through formal sustainability reports, which

[1] Environmental strategies refer to targeted actions – such as emissions reduction, waste management, and resource conservation – designed to mitigate ecological harm (Carter 2018).
[2] Sustainability initiatives encompass broader, integrated efforts to align organizational operations with the triple bottom line: economic viability, social equity, and environmental resilience (WCED 1987).

are key documents for tracking their environmental, social, and governance (ESG) efforts. Boston Logan and Singapore Changi were chosen for this study due to their status as major global hubs in aviation and pioneering sustainable airport policies. Despite having the second-smallest footprint among the top 20 major American airports, Boston Logan International Airport (BOS) is one of the nation's busiest airports, operating under Massport, which manages both aviation and maritime sectors (Massport, About Boston Logan 2024). The airport has recently committed to achieving net-zero emissions by 2031 (Massport, Environment: Sustainability 2024). Singapore Changi International Airport (SIN) is Singapore's primary international airport and a major aviation hub in the Asia-Pacific region. According to data from the Official Airline Guide (OAG), the airport was the third-best international airport in October 2023, behind Dubai (DXB) and London Heathrow (LHR) (OAG 2023). Singapore Changi adheres to global sustainability frameworks, including the Global Reporting Initiative (GRI), and aims for net zero by 2050 (Group, Sustainable Changi 2024). These airports offer valuable insights into how differing regional and global frameworks influence sustainability policy and reporting.

Geographical Context

This study examines Singapore Changi Airport and Boston Logan International Airport, two significant coastal aviation facilities that exemplify contrasting approaches to airport development and urban integration. While both serve as critical transportation nodes in their respective regions, their developmental trajectories, spatial configurations, and operational paradigms reflect distinct historical, geographical, planning, and political philosophies, which will be discussed thoroughly in the literature review chapter. The political context significantly shapes their approaches: Singapore's centralized governance structure enables rapid implementation of sustainability initiatives through direct state intervention (Phang 2003),

while Boston Logan operates within a complex federal system requiring coordination among multiple stakeholders and jurisdictions (Kitchin and Moore-Cherry 2021). These political frameworks fundamentally influence how environmental policies are conceived, implemented, and enforced. Through the following analysis of their physical characteristics, environmental integration, and infrastructural arrangements through Google Earth imagery, coupled with an examination of their governance structures and policy mechanisms, we can better understand the complex interplay between aviation facility development, urban spatial dynamics, and political systems that bring crucial insights into their environmental planning.

Figure 1: Google Earth Imagery of Boston Logan International Airport

Figure 2: Google Earth Imagery of Singapore Changi Airport

Spatial Configuration

The spatial positioning of Singapore Changi Airport and Boston Logan International Airport presents an intriguing study of coastal aviation infrastructure. While both facilities embrace their maritime interfaces, Changi's location on Singapore Island's eastern periphery reflects deliberate urban planning strategies that prioritize connectivity and efficient land use. (Meng, Zhang and Wong 2016), whereas Logan's development within Boston's historic harbor demonstrates adaptive infrastructure – where existing urban and natural frameworks are integrated into modern expansions. (Viskanta 1988). The contrasting approaches to water-adjacent airport placement reflect not only different epochs of aviation infrastructure development but also distinct philosophies in urban airport integration.

Topographical Characteristics and Environmental Integration

The terrestrial composition and environmental integration of these airports reveal divergent approaches to airport landscaping and land utilization. Changi's systematic incorporation of verdant buffer zones and calculated green spaces (Seng 2015), stands in marked contrast to Logan's more naturalistic integration with existing harbor topography (Nelkin 1974). This dichotomy extends beyond mere aesthetic considerations, suggesting fundamental differences in approaches to environmental mitigation and spatial optimization in airport design.

Transportation Infrastructure and Connectivity Paradigms

The surface transportation networks serving these airports characterize the contrast between planned and organic urban development. Changi's arterial system demonstrates a contemporary, systematic approach to airport accessibility, featuring purpose-engineered thoroughfares and intentional traffic flow patterns (Carrier 2024). Conversely, Logan's transportation infrastructure exhibits an evolutionary adaptation to Boston's historic street patterns, representing a more complex integration with the existing urban fabric (Cao, O'Connor and Were 2013).

Infrastructural Morphology and Operational Dynamics

These facilities' physical arrangement and operational infrastructure reflect their respective developmental contexts. Changi's geometric precision and parallel runway configuration exemplify modern aviation infrastructure planning (Phang 2003), while Logan's more irregular layout bears witness to the constraints and opportunities presented by Boston's harbor geography (Ny and Aranda 2015). These contrasting morphologies not only influence current operations but also shape future development potential and capacity evolution.

Justification for Airport Selection

Boston Logan and Singapore Changi are critical case studies due to their strategic importance in total numbers of annual passengers, global ranking and awards, sustainability initiatives, traffic, economic significance, and the differing political contexts they operate within. Below are the following differences that provide a rich basis for comparative analysis.

Global Recognition and Excellence Metrics

- **Global Ranking (Skytrax 2023):** The contrast in global rankings between these airports is notable, with Singapore Changi Airport securing a prestigious 9th place position in Skytrax'[3] World's Top 10 Airports while Boston Logan remains unranked in the top tier. This disparity reflects Changi's exceptional commitment to overall airport excellence, including its sustainability initiatives, passenger experience, and operational efficiency. The rankings suggest that Changi's integrated approach to airport management, including its sustainability practices, has contributed to its global recognition.
- **Awards and Achievements:** The disparity in recognition between these airports is striking. Singapore Changi Airport's impressive track record includes eight Skytrax "World's Best Airport" awards and consistent top 10 global rankings, highlighting its world-leading position in airport operations and sustainability. Boston Logan's 4-Star Skytrax rating and recognition for modernization efforts, while commendable, reflect a different level of global recognition. These achievements provide valuable context for

[3] Skytrax is the World Airline and Airport Star Rating program that classifies airlines and airports by the quality of product and staff service standards. "Skytrax Ratings." Accessed October 25, 2024. https://skytraxratings.com. "World's Top 100 Airports 2024." Accessed October 25, 2024. https://www.worldairportawards.com/worlds-top-100-airports-2024/.

understanding how each airport's sustainability initiatives are related to its overall performance and reputation.

Passenger Traffic Analytics and Consumer Experience

- **Annual Passengers (2021 Data):** Both Boston Logan International Airport and Singapore Changi Airport served remarkably similar passenger volumes in 2021, with Changi handling 42.6 million passengers (Group, Sustainable Changi 2024) compared to Logan's 42.5 million (Massport 2024). This comparable size makes them excellent candidates for comparison, as they face similar challenges in managing passenger volumes while implementing sustainable practices. The similar passenger numbers suggest that both airports must balance high operational demands with their environmental commitments, though they've taken different approaches to this challenge.
- **Passenger Satisfaction:** While both airports maintain high passenger satisfaction levels, their recognition occurs at different scales. Changi Airport's position as the Best Airport in Asia and consistent global top 10 rankings demonstrates its exceptional commitment to passenger experience (Skytrax 2024). Boston Logan's strong performance among U.S. airports, while impressive within its regional context, operates on a different scale (CBS 2024). This comparison highlights how sustainability initiatives can contribute to overall passenger satisfaction and airport experience.

Environmental Management and Sustainability Framework

- **Reporting Standards:** The contrasting sustainability frameworks employed by these airports reflect their different operational contexts, with Boston Logan following the regional Airports Council International (ACI) framework while Changi adopts the more

comprehensive global GRI Standards (Massport 2024). This difference in framework choice influences how each airport approaches sustainability reporting and benchmarking. Changi's use of GRI Standards suggests a more internationally oriented approach (CAG 2018), while Logan's regional framework may better address specific North American environmental challenges.

- **Carbon Emissions Reporting:** The depth and breadth of carbon emissions reporting differ significantly between the two airports. Singapore Changi Airport demonstrates a more comprehensive approach by covering all three scopes of emissions (Scope 1, 2, and 3), providing a complete picture of their carbon footprint (CAG 2018). In contrast, Boston Logan's focus on Scope 1 and 2 emissions, with limited Scope 3 coverage, suggests a more focused but potentially less comprehensive approach to emissions tracking (Massport 2024). This difference in reporting scope affects how each airport measures and manages its environmental impact.
- **Net-Zero Emissions Target:** The airports' divergent approaches to emissions targets are particularly interesting, with Boston Logan setting a more aggressive target of 2031 for net-zero emissions, compared to Changi's 2050 goal (CAG 2018). Logan's more ambitious timeline reflects Massport's urgent commitment to addressing climate change[4], while Changi's longer-term target aligns with Singapore's national climate strategy.[5] This difference in target dates provides an intriguing point of comparison for analyzing the feasibility and implementation strategies of accelerated versus gradual approaches to achieving net-zero emissions.

[4] Massport published "Sustainability & Resiliency Report" as their annual report in 2021. Massachusetts Port Authority. Massport Sustainability & Resiliency Report 2020–2021. January 2024. https://www.massport.com/sites/default/files/2024-01/2020-2021-Massport-Sustainability-Resiliency-Report.pdf.

[5] Changi Airport Group published "Sustainability Report 2020/21" for advancing sustainability in global crisis. Changi Airport Group. Annual Report 2022-2023. https://www.changiairport.com/content/dam/cacorp/publications/Annual%20Reports/2023/CAG%20AR22-23%20(Full).pdf.

- **Key Sustainability Initiatives:** Boston Logan's roadmap to net zero by 2031 includes energy conservation, clean transportation, and sustainable aviation fuel (SAF)[6] partnerships, while Singapore Changi has committed to net zero by 2050 with advanced energy management, SAF trials, and flood monitoring systems. Both airports emphasize innovative energy and emissions management, but Boston Logan's initiatives are geared toward a faster achievement timeline, possibly reflecting its more aggressive target. Changi's focus on real-time flood monitoring highlights an adaptation strategy for climate resilience, particularly relevant for a city-state susceptible to rising sea levels.

Social Impact Paradigm

- **Community and Social Responsibility:** Both airports show a strong commitment to community engagement but with different focuses. Boston Logan emphasizes DE&I initiatives and STEM education, reflecting American social priorities (Massport 2024), while Changi's approach through the Changi Foundation and green procurement policies demonstrates a more integrated approach to social responsibility (Foundation 2024). These different approaches reflect how airports can adapt their community engagement strategies to local social contexts while maintaining environmental commitments.
- **Government Social Responsibility (GSR):** The airports' approaches to GSR reflect their different regulatory and cultural contexts. Changi Airport's strong alignment with

[6] SAF is a biofuel used to power aircraft that has similar properties to conventional jet fuel but with a smaller carbon footprint. It is a drop-in fuel for aviation created from renewable or waste materials. Since they are drop-in compatible with the existing fleet, SAF is hydrocarbon fuel and thus emits CO2 when combusted in the aircraft engine. The extent to which any particular SAF provides a climate benefit depends on the SAF's life cycle emissions profile, taking into account the production, transportation, and combustion of the SAF, as well as the indirect effects associated with these. U.S. Department of Energy. "Sustainable Aviation Fuel." Accessed October 28, 2024. https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuels#:~:text=SAF%20is%20a%20biofuel%20used,with%20a%20smaller%20carbon%20footprint.

Singapore's Green Plan 2030 demonstrates close integration with national environmental policy (GreenPlan 2024), while Boston Logan's limited GSR details suggest a more autonomous approach to sustainability planning (Boston 2024). This difference highlights how national policy frameworks can influence airport sustainability strategies and reporting practices.

Research Question

How do airport sustainability policies compare in terms of their treatment of carbon emissions, ESG initiatives, and government social responsibility (GSR)?

Research Objective

The objective of this research is to conduct a comparative analysis of the sustainability policies at Boston Logan International Airport and Singapore Changi Airport, as reflected in their formal sustainability reports. This study aims to identify key gaps in their policies related to carbon emissions, ESG practices, and government social responsibility (GSR). Based on the findings, this research proposes recommendations for enhancing the transparency, scope, and effectiveness of sustainability policies in the aviation industry.

CHAPTER 2 - BACKGROUND

This chapter established the foundational contexts that shaped sustainability approaches at Boston Logan International Airport and Singapore Changi Airport through four critical lenses. First, I examined the geographical distinctions between North American and Asian urban development paradigms, which informed each airport's environmental priorities. Second, I analyzed the political-institutional frameworks governing policy implementation, highlighting how regulatory environments enabled or constrained sustainability initiatives. Third, I investigated ownership structures and their influence on decision-making processes, contrasting Massport's public authority model with Changi's corporatized government-linked framework. Finally, I assessed operational scales and their implications for environmental impact management, from Logan's regional Northeast U.S. focus to Changi's global aviation hub status.

Through this comparative structure, the chapter revealed how these contextual factors produced divergent sustainability strategies despite shared climate goals. The analysis drew on academic literature, government documents, and industry reports to construct a rigorous basis for evaluating each airport's sustainability policies in subsequent chapters. Subsequent sections demonstrated these frameworks' concrete manifestations in urban planning, transportation systems, and operational models at both airports.

Boston Logan International Airport

Urban Planning and Development

The evolution of Boston's urban landscape reflects complex interactions between preservation efforts, community activism, and development pressures. Seasholes (2018) underscores the significance of urban spaces in Boston, framing urban planning as an evolving discipline that

blends technical and liberal arts principles. Minner's (2016) historical study of preservation and planning in America, particularly Boston's influence, aligns with Seasholes' perspective on urban space transformation.

The literature reveals tensions between various stakeholders in Boston's development process. Porter (2015) examines the contentious nature of development planning in Boston's Standard Metropolitan Statistical Area (SMSA), while Yonk and Simmons (2014) analyze planning commissioners' decision-making, revealing how staff expertise, personal biases, and public feedback shape outcomes. Abbott (2018) further examines these dynamics through an analysis of governance and planning in fragmented metropolitan regions like Boston, emphasizing the varying levels of authority among planning agencies.

Transportation Systems and Innovation

The transportation literature specific to Boston Logan International Airport reveals a dynamic interplay between historical infrastructure development and contemporary policy innovations. Early foundational works, such as Vogel (1988), trace the airport's integration into regional transportation networks, while Diefendorf (2018) contextualizes its current operational challenges within broader urban planning frameworks. These studies collectively underscore how Logan's growth has been shaped by both legacy infrastructure constraints and evolving mobility demands.

Equity and accessibility remain critical policy concerns in airport-related transportation systems. Austin and Zegras (2012) evaluate the role of ground transportation services, including taxis and ride-sharing, in connecting Logan to the broader Boston metropolitan area. Their findings align with Ge et al. (2016), whose research exposes disparities in transportation network company (TNC) services that disproportionately affect marginalized communities accessing the airport. These equity gaps are further substantiated by James et al. (2014), who

analyze the public health implications of transit modifications impacting airport-bound routes, particularly for low-income populations reliant on public transportation.

Innovations in ground transportation planning directly influence Logan's operational policies. Bertsimas et al. (2019) propose optimization models applicable to airport shuttle networks, while Nelson et al. (2005) assess the potential for bus rapid transit (BRT) enhancements to improve airport accessibility. Non-motorized transit also features prominently in policy discussions, with Bongiorno et al. (2019) providing empirical data on pedestrian and cycling infrastructure gaps in airport-adjacent areas, a key consideration for Logan's sustainability initiatives.

Aviation-specific studies highlight Logan's pivotal role in regional air transportation. Abbott and Bamforth (2019) chronicle the airport's historical expansion and its enduring challenges with airspace congestion, particularly along the Boston-Washington corridor. Hudda et al. (2016) reinforce these findings, warning of capacity limitations that necessitate multimodal alternatives to short-haul flights.

Emerging technologies are reshaping Logan's policy landscape. Tuchen et al. (2022) evaluate Urban Air Mobility (UAM) applications for the airport, including air taxis and cargo drones, which could alleviate ground traffic while introducing new regulatory complexities. Their framework underscores Logan's potential as a testbed for integrating UAM into existing transportation ecosystems, a priority reflected in recent Massachusetts Port Authority (Massport) strategic plans.

Airport Operations and Regional Connectivity

Boston Logan (BOS) is experiencing significant growth and development. According to Massport (2024), the airport served a record-breaking 43.5 million passengers in 2024,

demonstrating its position as a major hub in the northeastern United States. It currently offers direct flights to over 100 domestic and international destinations through more than 40 airlines.

The airport is expanding its international reach in 2025 with several new routes. Delta (2024) is launching four weekly flights to Milan and three times weekly service to Barcelona starting May 2025. JetBlue (2024) is introducing daily flights to Madrid and Edinburgh from May 22 to October 24, 2025.

Logan Airport offers extensive ground transportation options as well. The SL1 bus services all terminals and connects to the Red Line and Commuter Rail at South Station (MBTA 2024) along with free Massport shuttle service between terminals and the Airport MBTA Station on the Blue Line Logan Express bus service operates from Back Bay, Braintree, Framingham, Peabody, and Woburn (Service 2024). Logan Airport offers diverse transportation options, including ferry services and private bus carriers such as Peter Pan Lines, Concord Coach Lines, and Boston Express, facilitating passenger connectivity.

The airport is undergoing significant modernization projects to enhance capacity and passenger experience (Massport 2025), including Terminal E modernization with four new gate piers, roadway and facility improvements, and enhanced sustainable infrastructure.

Singapore Changi Airport

Urban Planning and Development

Singapore's urban landscape reflects a comprehensive approach to city planning that integrates transportation and land use. Wang, Zhang and Fuh (2010) examine Singapore's transformation into a sustainable city-state through integrated planning approaches. This is complemented by Koh and Lee (2022) analysis of Singapore's urban development strategies, particularly focusing on the integration of transportation infrastructure with land use planning.

The literature highlights Singapore's innovative approach to urban mobility planning. (Zahraei, Kurniawan and Cheah (2019) document the significant milestone of implementing the world's first fully automatic heavy rail Mass Rapid Transit system, demonstrating Singapore's commitment to pioneering transportation solutions. Haque, Chin and Debnath (2013) further elaborate on Singapore's intelligent transportation solutions, including electronic road pricing, computerized traffic signaling systems, and integrated ticketing systems.

Transportation Systems and Innovation

The transportation literature pertaining to Singapore Changi Airport demonstrates a meticulously planned integration of cutting-edge technologies and policy frameworks. Wang, Zhang, and Fuh (2010) establish the foundation for routing optimization through genetic algorithms, which directly informs Changi's ground transportation management systems. This technical approach is complemented by Liu, Wen, and Jian (2024), whose examination of Mobility-as-a-Service (MaaS) implementation through Singapore's living labs reveals how Changi serves as a testbed for multimodal connectivity solutions.

Singapore's distinctive transportation demand management strategies significantly influence Changi's operational policies. Boey and Su (2014) provide critical insights into how Singapore maintains exceptionally low land transportation energy consumption, with Changi Airport serving as a prime example of this efficiency through its integrated rail and road networks. Nyhan et al. (2016) further substantiate these findings through their analysis of vehicular emissions prediction, demonstrating how Changi's transportation policies incorporate real-time environmental monitoring.

The evolution of Changi's air transportation ecosystem reflects Singapore's broader commitment to technological leadership and environmental stewardship. Tan and Low (2021) present groundbreaking research on cross-border urban air mobility, with Changi positioned as

the potential hub for multi-rotor eVTOL aircraft operations across Southeast Asia. This forward-looking approach aligns with regional aviation management studies, particularly Putro, et al. (2024), who analyze air navigation agreements that directly impact Changi's role as a regional aviation leader.

Airport Operations and Regional Connectivity

The operational aspects of Singapore's aviation sector have received significant attention in recent literature. Meng et al. (2021) analyze the impact of different control policies on the air transportation industry, particularly comparing Singapore's approach with other major aviation hubs. This is complemented by Easa and Yan (2019) comprehensive examination of civil engineering aspects in aviation infrastructure.

Geographic Variations in Airport Sustainability Approaches

Regional differences in sustainability policy implementation and reporting practices significantly influence how airports approach environmental challenges. North American airports, exemplified by Boston Logan International Airport, typically demonstrate a distinct approach characterized by short-term environmental targets and regional framework adherence (Federal Aviation Administration 2021). Research indicates that U.S. airports often prioritize immediate operational emissions reductions and local community engagement while placing relatively less emphasis on comprehensive Scope 3 emissions reporting (Carlini 2013). This regional pattern reflects broader North American transportation infrastructure trends, where environmental policies are often driven by regional frameworks and immediate operational concerns rather than comprehensive global standards.

In contrast, Asian airports, particularly those in developed economies like Singapore, demonstrate a different approach to sustainability policy implementation (Wang and Song

2020). Singapore Changi Airport represents an Asian approach characterized by comprehensive reporting frameworks and strong alignment with national environmental policies (Seo 2021). Comparative studies of transportation infrastructure sustainability have revealed that Asian airports typically demonstrate more integration with national environmental policies and sustainability reporting practices (Sreenath, Sudhakar and Yusop 2021). This pattern extends beyond airports to other transportation infrastructure, where Asian facilities generally demonstrate more comprehensive environmental management systems and stronger government policy integration compared to their North American counterparts (Xiong, et al. 2023). These regional variations in sustainability approaches between Asian and North American transportation infrastructure reflect broader differences in policy implementation, governance structures, and environmental management strategies.

Boston Logan International Airport

Climate Resilience and Adaptation in Aviation

Central to Massport's environmental strategy is the reduction of GHG emissions across multiple operational domains. The "Roadmap to NetZero" initiative targets emissions from owned facilities, ground support equipment, and purchased energy sources (Massport 2022). This multi-faceted approach is critical, as airports are significant contributors to global carbon emissions due to their energy-intensive operations. According to a study by (Ryley and Baumeister 2022), airports account for approximately 5% of global aviation-related emissions, with ground operations and energy consumption being major contributors. Massport's efforts to transition to renewable energy sources, electrify ground support equipment, and enhance energy efficiency in terminal buildings demonstrate a commitment to mitigating these impacts.

Under a 20-year Power Purchase Agreement with Ameresco, solar PV systems were installed at Boston Logan's LEED-certified Terminal A, generating 430,000 kWh annually. Funded in part by American Recovery and Reinvestment Act (ARRA) stimulus money through Massachusetts' Solar Stimulus Program (MaSS), the project provided Massport with discounted solar electricity, resulting in reduction in both energy costs and emissions by 297 metric tons of CO_2 yearly which is equivalent to the carbon sequestration of 243 acres of U.S. Forest. After receiving the 2010 award from the Massachusetts Department of Energy Resources, Ameresco installed solar PV panels on Terminal A, making it the world's first LEED-certified airport terminal with solar technology (Ameresco 2020). Furthermore, the adoption of carbon offset programs and partnerships with renewable energy providers underscores the airport's holistic approach to emissions reduction.

Boston Logan's coastal location makes it particularly vulnerable to climate-related risks. Recent studies (Fitzgerald and Hobbs 2022) have highlighted the airport's critical role in regional infrastructure and the need for comprehensive protection measures. The airport has undertaken extensive vulnerability assessments to identify critical areas requiring adaptation measures.

The airport has implemented a multi-layered approach to flood protection. A comprehensive floodproofing design guide was developed in 2025, incorporating detailed flood mapping and maximum flooding extent analysis (Massport 2025). Flood doors and strategic relocation of critical equipment to higher elevations were also installed (Bidgood 2015). Massport (2025) also published a resiliency plan and integrated it into the Stormwater Pollution Prevention Plan with the guidelines for a floodproofing design and sustainability design (Massport 2025)[7]. The

[7] The Massachusetts Port Authority's (Massport) Sustainability Design Guidelines establish comprehensive standards that extend beyond the organization's Net Zero Roadmap, which primarily focuses on operational emissions (Scopes 1 and 2), to address embodied carbon and indirect emissions (Scope 3) while codifying existing sustainable practices and environmental stewardship goals. These Guidelines take a holistic approach to achieving

Logan Airport Sustainability Management Plan has established a framework with specific performance targets, integrating climate resilience into broader environmental management systems (Massport, Sustainable Massport 2016)[8].

In addition to mitigation efforts, Massport has prioritized climate resilience planning to address the growing risks posed by climate change. This includes incorporating resilience strategies into stormwater management systems and developing environmental management systems that account for future climate scenarios. The Intergovernmental Panel on Climate Change (IPCC) has emphasized the need for adaptive infrastructure to mitigate the impacts of extreme weather events, sea-level rise, and other climate-related challenges (IPCC 2022). Massport's proactive approach to resilience planning ensures that Boston Logan Airport is prepared to withstand and adapt to these challenges, safeguarding its operations and surrounding communities.

Boston Logan Airport Policies

Several key studies provide valuable insights into the complexities of Boston Logan Airport policies particularly focusing on sustainability. Research in Environmental Research Letters (Greer, Rakas and Horvath 2020) emphasizes the need for sustainability metrics that extend beyond conventional environmental accounting. Similarly, studies in sustainable urban development argue that effective airport sustainability requires integrating social and environmental management systems (Santa, et al. 2020). These frameworks provide a basis for evaluating Logan Airport's sustainability strategies.

sustainable and resilient outcomes that benefit both people and planet, supporting Massport's commitment to reaching net zero emissions by 2031 through consistent implementation across all Authority projects.

[8] The 2016 Logan Airport Annual Sustainability Report summarized the progress of sustainability initiatives at Boston-Logan International Airport, tracking achievements against the goals and targets established in Massport's 2015 Sustainability Management Plan. The report documented significant accomplishments since the 2015 plan's publication and outlined Massport's strategic vision for establishing itself as a sustainable organization through its "Sustainable Massport" framework.

While significant progress has been made, the airport continues to evolve its environmental strategies. The recent hiring of a climate and resilience officer underscores Massport's commitment to ongoing environmental leadership (AviationPros 2025).

A study by Bongiovanni and Newton (2018) highlights the importance of adopting a systems-based approach to airport environmental management, emphasizing the interconnectedness of social, economic, and environmental factors. This perspective aligns with Massport's holistic strategy, which integrates emissions reduction, water conservation, noise abatement, and resilience planning into a unified framework. Furthermore, research by Goetz and Graham (2004) underscores the role of stakeholder engagement in achieving sustainable aviation outcomes, a principle that is evident in Massport's community-focused initiatives.

The Massachusetts Port Authority (Massport), as the governing body of Boston Logan International Airport, has established a comprehensive environmental management framework that underscores its commitment to sustainability. This commitment is exemplified by the ambitious "Roadmap to NetZero" initiative, which aims to achieve net-zero greenhouse gas (GHG) emissions by 2031, nearly two decades ahead of federal and state-mandated targets (Massport 2022). This proactive approach reflects a broader institutional recognition of the critical role that transportation hubs play in addressing global environmental challenges. Massport's strategy aligns with international sustainability frameworks, such as the United Nations Sustainable Development Goals (SDGs), particularly Goal 13 (Climate Action) and Goal 9 (Industry, Innovation, and Infrastructure). By integrating these global priorities into its operational policies, Massport positions Boston Logan Airport as a leader in sustainable aviation infrastructure.

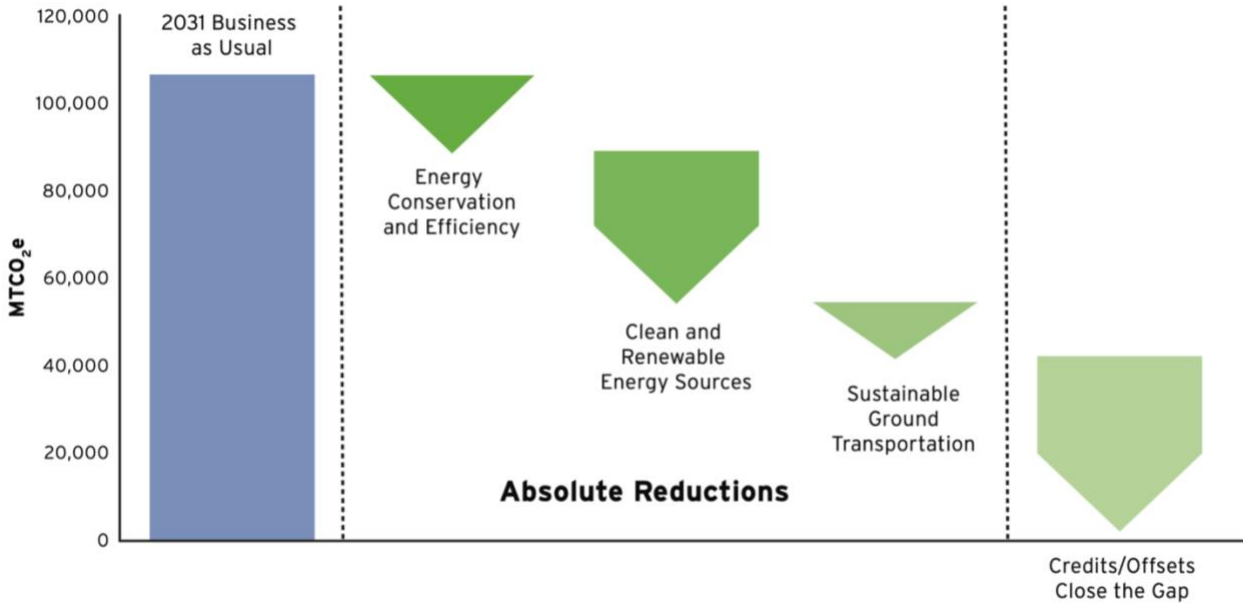

Figure 3: Scope 1 and 2 Emissions, Mitigation by pathway (2031). Source *(Massport 2022)*, image uploaded in the report "Net Zero by 2031" by Massport

Environmental considerations specific to Logan Airport form a crucial component of the literature. Chung et al. (2023) provide valuable insights into the relationship between aircraft noise frequencies and particulate emissions in Greater Boston, focusing on communities surrounding Logan Airport. These findings align with broader studies of airport-related environmental impacts and mitigation strategies.

The airport's coastal location presents unique challenges in the context of climate change. Baglin (2012) addresses the critical issue of coastal flooding and climate change adaptation for Logan Airport and surrounding metropolitan communities, emphasizing the need for adaptable planning strategies. Kwakkel, Walker, and Marchau (2010) build upon this work, advocating for adaptable planning strategies and sustainable policies to address rising sea levels affecting airport operations and infrastructure.

Water conservation is another cornerstone of Massport's sustainability strategy. Recognizing the importance of protecting regional water resources, the airport has implemented programs aimed at reducing potable water consumption and promoting sustainable water management practices. These initiatives are particularly significant given the increasing stress on water resources due to climate change and population growth. Research by Harris-Lovett, Lienert, and Sedlak (2018) highlights the importance of integrated water resource management in urban infrastructure, emphasizing the need for adaptive strategies that account for future climate uncertainties. Massport's efforts to incorporate water-efficient technologies, such as low-flow fixtures and rainwater harvesting systems, align with these scholarly recommendations and contribute to the broader goal of environmental sustainability.

Noise pollution is a critical environmental and public health issue associated with airport operations. Prolonged exposure to aircraft noise has been linked to adverse health outcomes, including cardiovascular disease and sleep disturbances (Black, et al. 2007). Logan International Airport worked on airport noise mitigation through a comprehensive series of initiatives spanning over four decades. The airport's efforts began with the implementation of one of the nation's first community noise monitoring systems, followed by initiating the first FAA-funded school soundproofing program in 1981 (Massport 1989), which has since expanded to include over 11,000 residential units and 36 schools with an investment exceeding $170 million. The airport's commitment to noise reduction is further demonstrated through its strict Noise Abatement Rules and Regulations, which encompass runway usage restrictions, ground operation limitations, and the prohibition of outdated engine technologies (Massport 1986). This dedication to community-focused noise management culminated in a landmark 2016 Memorandum of Understanding with the FAA, establishing an unprecedented collaborative study examining flight concentration patterns and their impact on community noise levels, with several recommendations having been implemented since December 2021

and others still under development (Massport 2024). In these targeted noise abatement strategies, targets were implemented such as optimizing flight paths, promoting the use of quieter aircraft, and establishing noise insulation programs for affected communities (see annexure 1). These measures not only address environmental concerns but also foster positive relationships with local stakeholders, demonstrating the airport's commitment to social sustainability.

The following map presents the results of AEDT noise modeling for 2022, including graphical DNL contours, tabulated population within contour intervals, and comparisons between modeled and measured noise levels at specific monitor locations, with historical data provided for context. The analysis focuses on DNL 65 dB, the threshold for residential land use incompatibility while noting that 2022 aircraft operations at Logan Airport remained 11% below 2019 levels, with variations in fleet mix, nighttime operations, and runway use (VHB 2022).

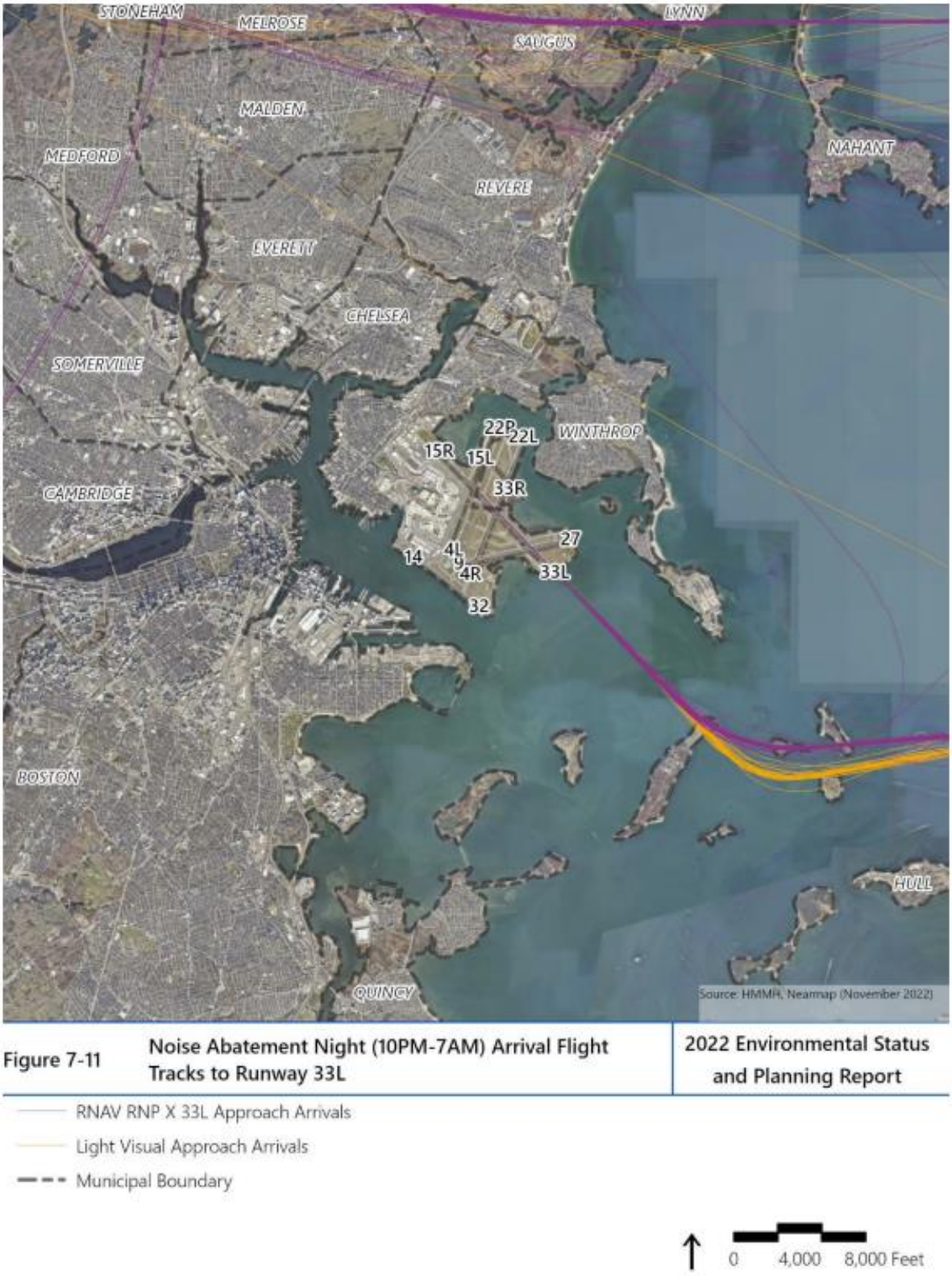

Figure 4: Map of Noise Abatement Night Arrival Flight at Logan Airport. Source: *(VHB 2022)*

Massport's adoption of the LEED (Leadership in Energy and Environmental Design) framework for infrastructure development reflects a commitment to sustainable design and construction practices (Massport 2018). LEED certification ensures that new and renovated facilities meet rigorous environmental standards, including energy efficiency, water conservation, and indoor environmental quality. This approach aligns with scholarly research emphasizing the importance of green building practices in reducing the environmental footprint of urban infrastructure (Kibert 2016). By integrating LEED principles into its development projects, Boston Logan Airport sets a benchmark for sustainable infrastructure in the aviation sector.[9]

Singapore Changi Airport

Climate Resilience and Adaptation in Aviation

The literature emphasizes Singapore's approach to climate resilience in aviation. Periyakoil et al. (2020)[10] examine environmental parameters affecting aviation operations, while additional studies focus on adaptation strategies for Singapore's aviation infrastructure in response to climate change challenges. Changi Airport Group (CAG) has developed an innovative methodology in collaboration with Netherlands Airport Consultants (NACO) to map and mitigate climate change risks. A comprehensive benchmarking analysis was conducted by Dolman and Vorage (2020) to evaluate Singapore Changi Airport's climate change adaptation strategies in comparison to its international counterparts. The findings revealed that while

[9] Boston Logan International Airport has demonstrated consistent leadership in sustainable building practices since its pioneering achievement in 2005, when Terminal A became the world's first airport terminal to receive LEED certification from the U.S. Green Building Council (USGBC). This commitment to environmental stewardship has resulted in a substantial portfolio of eight LEED-certified projects as of fall 2022, with two additional projects under development and multiple tenant spaces achieving certification. The LEED framework serves as a cornerstone of Massport's sustainability strategy, enabling the implementation of cutting-edge environmental design and construction methodologies while simultaneously advancing the organization's sustainability objectives and expanding its institutional expertise in high-performance building systems.

[10] (Periyakoil, Das and Spanos 2020)

numerous airports globally face significant climate-related challenges, particularly increased flooding risks during extreme weather events, relatively few have implemented substantial mitigation measures. Singapore's proactive approach stands out in this context, as Changi Airport has not only acknowledged the potential threats to its coastal infrastructure but has also initiated concrete flood protection measures to enhance operational resilience and ensure long-term service continuity. This strategic focus on climate adaptation demonstrates Singapore's commitment to safeguarding critical aviation infrastructure against emerging environmental challenges. This approach has positioned Changi as a frontrunner in airport climate adaptation.

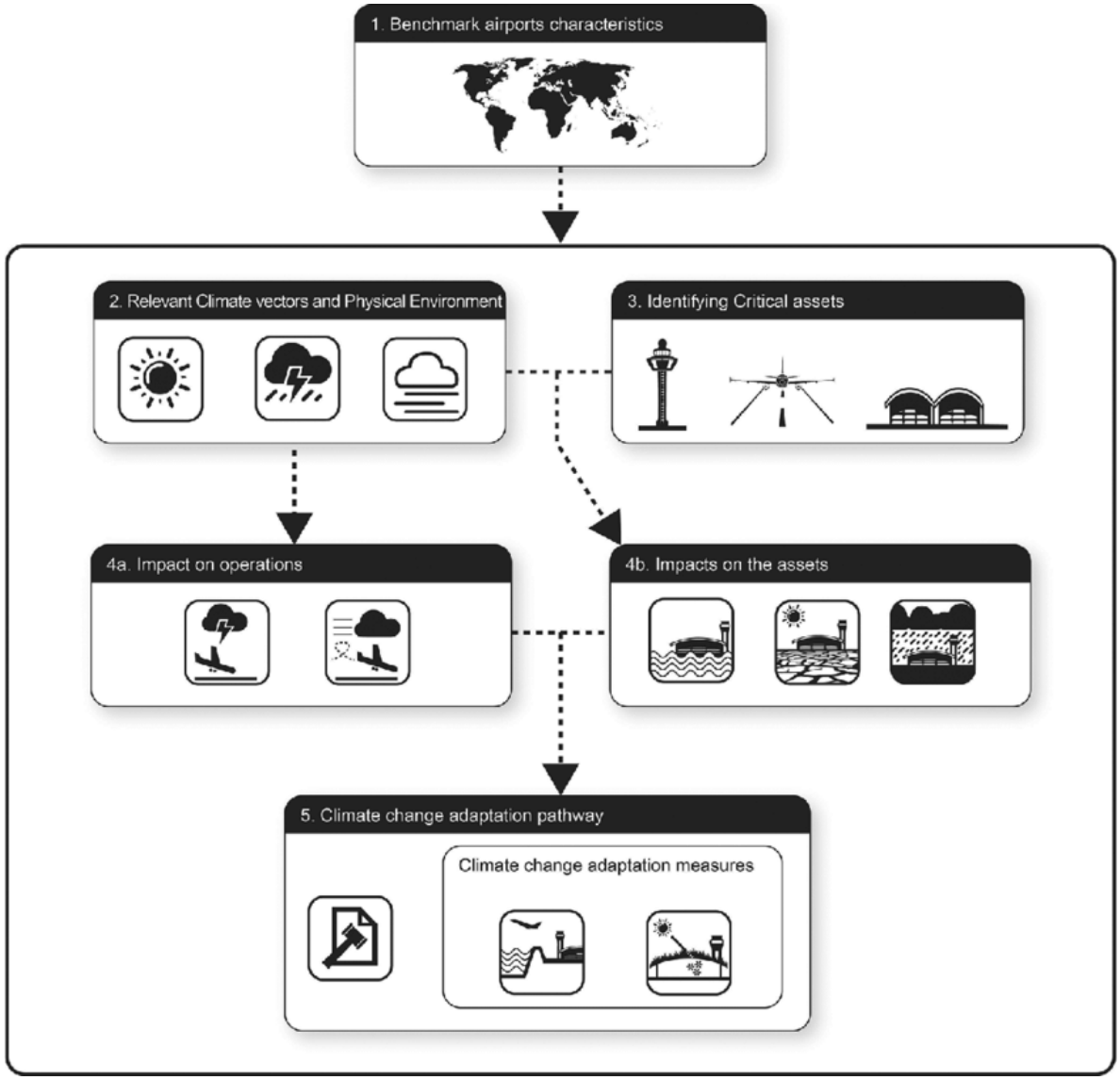

Figure 5: Climate change risks mitigation. Source: *(Dolman and Vorage 2020)*, image uploaded by Nanco Dolman[11]

After that, Changi Airport implemented several key adaptation strategies. The runway design was modified, including grooved surfaces to reduce aquaplaning risks during intense thunderstorms (Group, Sustainable Changi 2023). Development of climate risk mapping was completed through 2050, with an ongoing solution development for identified challenges (ATAG 2022). Implementation of a whole-of-government adaptation pathway (Dolman and

[11] Changi Airport Group (CAG) has developed an innovative methodology in collaboration with Netherlands Airport Consultants (NACO) to map and mitigate climate change risks.

Vorage 2020) to counter the effects of sea level rise. Changi Airport takes a comprehensive view of environmental sustainability, focusing on emissions reduction, waste management, water conservation, climate resilience, and carbon offset programs (Group 2025).

A study published in the Journal of Environmental Management identifies Changi as a leader among ASEAN airports in implementing sustainable solutions, particularly in areas such as energy efficiency and waste management (Sreenath, Sudhakar and Yusop 2021). The study highlights the airport's integrated approach to environmental management, which combines technological innovation with stakeholder engagement to achieve sustainability goals. Additionally, recent research by Ren (2024) emphasizes Changi's innovative strategies for climate change adaptation and mitigation, including advanced stormwater management systems and urban heat island reduction measures.

At the core of Changi Airport's sustainability efforts is its adherence to internationally recognized environmental management standards. The airport has achieved ISO 14001:2015 certification[12] across its energy and emissions, waste management, and water management systems (Group 2025). This certification reflects a systematic approach to environmental management, emphasizing continuous improvement and accountability. The ISO 14001 framework provides a structured methodology for identifying, managing, and mitigating environmental impacts, ensuring that sustainability is embedded in all operational processes. According to research by Boiral and Heras-Saizarbitoria (2017), ISO 14001 certification is a critical driver of environmental performance in organizations, as it fosters a culture of transparency and proactive environmental management. Changi's adherence to these standards

[12] The ISO 14001 standard provides an internationally recognized framework for organizations to design, implement, and continuously enhance their environmental management systems (EMS), enabling systematic improvement of environmental performance through structured protocols and methodologies (ISO 2015).

underscores its commitment to maintaining rigorous environmental controls and achieving measurable sustainability outcomes.

Changi Airport has set targets for carbon emissions reduction, aiming for zero carbon growth until 2030, with absolute emissions capped at 2018 levels (Aviation 2022). As of the latest reporting period published by DitchCarbon, the airport's carbon emissions stand at approximately 966,000,000 kg CO2e, with comprehensive monitoring of both Scope 1 (direct emissions) and Scope 2 (indirect emissions from purchased energy) (DitchCarbon 2025).

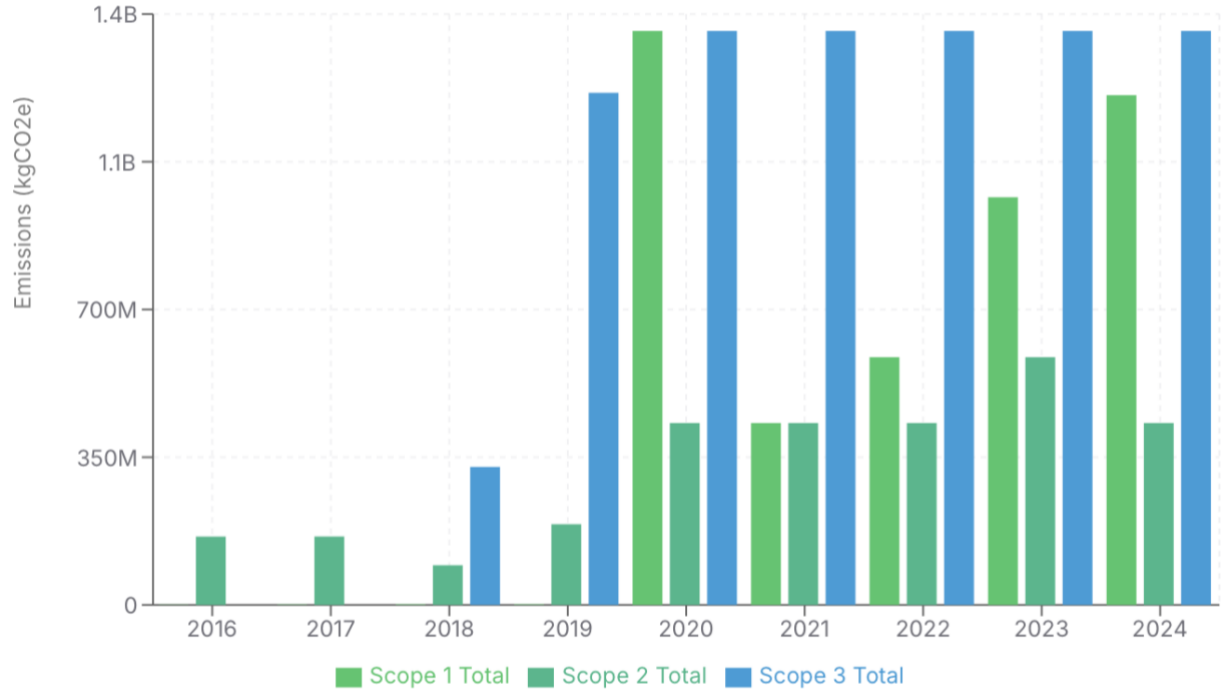

Figure 6: Changi Airport's reported carbon emissions. Source: *(DitchCarbon 2025)*[13]

[13] DitchCarbon provides aggregated company-disclosed emissions data normalized to GHG Protocol standards. A comprehensive analysis of Changi Airport's carbon emissions profile in 2023 reveals a total carbon footprint of approximately 966,000,000 kg CO2e, with disaggregated emissions across all three scopes: Scope 1 emissions at 966,000,000 kg CO2e, Scope 2 at 587,000,000 kg CO2e, and Scope 3 at 1,360,000,000 kg CO2e, representing a notable increase from the 2022 total of 587,000,000 kg CO2e. The airport's environmental performance metrics include a documented emissions intensity of 2.57 kg CO2e per passenger in 2019 for Scopes 1 and 2, demonstrating their commitment to granular emissions tracking and transparent reporting methodologies. While specific reduction targets remain undisclosed, Changi Airport's comprehensive emissions accounting approach across all three scopes indicates a robust framework for carbon footprint assessment, establishing a foundation for future sustainability initiatives and alignment with international climate action protocols.

These efforts align with global aviation sector targets, including ICAO's goal of carbon-neutral growth from 2020 onwards. Scheelhaase et al. (2018) highlights the importance of robust emissions monitoring and reporting in achieving aviation sustainability goals, emphasizing the need for transparency and accountability. Changi's approach to carbon management exemplifies these principles, leveraging advanced data analytics and emissions-tracking systems to inform decision-making and drive reductions.

Changi Airport Policies

As one of the busiest airports in the world, Changi's approach to environmental impact and sustainability is not only a response to regulatory requirements but also a strategic alignment with global environmental goals, such as the United Nations Sustainable Development Goals (SDGs) and the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Environmental considerations in Singapore's aviation industry are a strategic component. Chua et al. (2010) provide valuable insights through their life cycle emissions study of alternative aviation fuels. Grundy-Warr and Savage (2016) examine broader waste management options and their impact assessment in Singapore's aviation sector, while Molina et al. (2019) analyze air quality improvements through modal shifts in transportation systems.

Another pillar of Changi's sustainability strategy is the integration of renewable energy sources into its operations. The airport has installed extensive solar panel systems across its premises, generating significant renewable energy to power its facilities (UGreen 2024). Additionally, Changi has implemented energy-efficient technologies, such as LED lighting and advanced chilling systems, to reduce overall energy consumption (MOT 2025). This is further supported by Zhou (2022) highlighting the potential of solar energy in mitigating carbon emissions from airports, particularly in regions with high solar irradiance, such as Singapore. Changi's

investment in renewable energy not only reduces its reliance on fossil fuels but also sets a benchmark for other airports in the region.

Changi Airport's infrastructure development is guided by sustainable design principles, as exemplified by the iconic Jewel complex. This multi-use facility incorporates green building standards, such as energy-efficient systems, natural ventilation, and extensive greenery, to minimize its environmental impact (BillionBricks 2024). Kibert (2016) emphasizes the importance of green building certifications, such as LEED and BREEAM, in promoting sustainable construction. Changi's commitment to green infrastructure extends beyond individual projects, with a broader focus on embedding sustainability into all aspects of airport development. This approach not only enhances operational efficiency but also contributes to the airport's aesthetic and environmental appeal.

Figure 7: Jewel Changi Airport / Safdie Architects / ArchDaily. Source: *(BillionBricks 2024)*

Changi Airport has implemented a comprehensive waste management strategy that emphasizes a lifecycle approach to resource use. This includes green procurement practices, material reuse, and environmentally sound operational procedures (Group 2023). According to a study by Ghisellini and Ulgiati (2020), the adoption of circular economy practices in urban infrastructure can significantly reduce environmental impacts while promoting economic efficiency. Changi's focus on waste reduction and resource conservation reflects these principles, demonstrating a commitment to sustainable resource management.

Changi Airport's commitment to environmental sustainability is further reinforced through operational initiatives such as the Truck Dock Slot Booking system, which optimizes landside operations to reduce emissions and improve efficiency (Group 2024). This initiative reflects a

broader integration of environmental considerations into all aspects of airport operations, from ground handling to passenger services. According to research by Graham (2020), operational efficiency is a critical component of airport sustainability, as it reduces resource consumption and minimizes environmental impacts.

Looking ahead, Changi Airport Group has outlined specific environmental objectives, including a 20% reduction in domestic aviation emissions from airport operations by 2030 (based on 2019 levels) and the achievement of net-zero emissions through technological innovation and renewable energy adoption (Davies, et al. 2024). These targets are aligned with global aviation sector goals, such as the Air Transport Action Group's (ATAG) commitment to net-zero emissions by 2050[14]. Singapore's Sustainable Air Hub Blueprint (2024)[15] establishes ambitious decarbonization targets, aiming to reduce domestic aviation emissions by 20% from 2019 levels (404ktCO2) by 2030 and achieve net-zero emissions across both domestic and international aviation operations by 2050, aligning with Singapore's national climate objectives and the International Civil Aviation Organization's global industry targets. To realize these goals, the Civil Aviation Authority of Singapore (CAAS) has introduced a comprehensive framework comprising 12 decarbonization initiatives across the airport, airline, and air traffic management domains, supported by five critical enablers to ensure effective implementation (Davies, et al. 2024).

[14] The aviation sector has identified four main pillars of action to get to net zero: new technologies, improvements in operation and infrastructure, the shift to sustainable aviation fuels, and market mechanisms to deal with any residual emissions. (Waypoint 2024)

[15] Civil Aviation Authority of Singapore, 19 February 2024, Singapore Sustainable Air Hub Blueprint. Available at: https://www.caas.gov.sg/docs/default-source/docs – so/singapore-sustainable-air-hub-blueprint.pdf. (Davies, et al. 2024)

Table 1: Singapore Sustainable Air Hub Blueprint Initiatives. Source: *(Davies, et al. 2024)*

Airport domain	**Airline domain**	**Air traffic management domain**
• Solar power deployment	• National sustainable aviation fuel (SAF) target and SAF levy	• Advanced demand-capacity balancing implementation
• Clean energy airside vehicles	• Central SAF procurement	• Performance-based navigation enhancement
• Building energy efficiency	• SAF production in Singapore and the region	• Gate-to-gate trajectory optimization
• Low-carbon electricity imports	• Airline fleet renewal and operational improvements	
• Resource circularity through waste-to-energy		

Critical enablers:

(1) Policy and regulation

(2) Industry development

(3) Infrastructure planning and provision

(4) Workforce transformation

(5) International partnerships and collaborations

CHAPTER 3 - LITERATURE REVIEW

Policies, particularly in high environmental impact sectors such as aviation, are a growing area of concern for policymakers and stakeholders. Airports are major contributors to greenhouse gas (GHG) emissions due to air traffic, ground operations, and infrastructure development. Sustainability reporting has evolved into a complex ecosystem of documentation types: annual sustainability updates that track progress against established metrics, long-term policy statements that outline strategic environmental objectives, and comprehensive master plans that integrate sustainability into future development scenarios. These reports vary significantly in scope and detail, with some focusing primarily on environmental metrics while others encompass broader social and economic impacts (Oprean-Stan, et al. 2020). Through formal reports, airports can operationalize environmental policy, enabling governments and regulatory bodies to assess their compliance with national and international climate goals (Koç and Durmaz 2015).

This literature review is organized to examine multiple dimensions of airport variation discussing the role of environmental policy and reporting, focusing on challenges with Scope 1, Scope 2, and especially Scope 3 emissions. The review also covers carbon emissions policies and the complexities of comprehensive reporting. Finally, ESG and government social responsibility (GSR) frameworks are explored for their role in promoting sustainable development. This roadmap outlines key aspects of airport sustainability and highlights gaps this study will address.

Global Sustainability Reporting in the Aviation Industry

The Airports Council International's (ACI) Airport Carbon and Emissions Reporting Tool (ACERT), launched in 2023, has become instrumental in standardizing carbon reporting across

global airports (Papagrigoriou, Palantzas and Nalmpantis 2023). This tool, alongside the Airport Carbon Accreditation (ACA) program, provides a comprehensive framework for measuring, reporting, and verifying airports' carbon emissions. The Science Based Targets initiative (SBTi) has developed specific guidance for airports, with 127 major airports now committed to science-based emission reduction targets (Halterman, Kessler and Morgan 2024). Moreover, the Partnership for Sustainable Aviation (PSA), a coalition of 89 airports, airlines, and industry stakeholders, has established the Aviation Sustainability Metrics Framework (ASMF), which standardizes sustainability reporting across the aviation sector (IBAC 2022). Research by the International Air Transport Association (2024) shows that airports participating in these standardized reporting frameworks achieve carbon reduction targets 45% faster than non-participating airports (ACI 2023).

Environmental policy defined as regulatory and institutional measures to mitigate ecological harm directly influences airport sustainability efforts, which encompass long-term operational practices that balance economic, social, and environmental priorities.

. In the context of airports, sustainability reports serve as a formalized means of implementing and communicating policy decisions (Saykili 2024). These reports are often aligned with frameworks such as the Global Reporting Initiative (GRI) or the Sustainability Accounting Standards Board (SASB), which guide the scope of ESG disclosures (Karaman, Kilic and Uyar 2018). Airports, as global transportation hubs, are under increasing pressure to reduce their environmental footprint. Effective sustainability reporting, particularly when integrated into environmental policy, allows airports to address emissions across all scopes: Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (indirect emissions from third parties, such as airlines and passengers) (Xiong, et al. 2023). However, research indicates that many airports struggle with comprehensive Scope 3 emissions

disclosures, which are critical for understanding the full environmental impact (Ritter, Bertelsen and Haseman 2011).

Along with sustainability reporting, carbon disclosure has become a fundamental requirement for airport operations globally, driven by increasing regulatory pressure and stakeholder demands for transparency (L'Abate, et al. 2023). Ann Graham discussed in her book "Managing Airports - An International Perspective" that the Global Reporting Initiative (GRI)[16] standards, established in 1997, serve as the primary framework for sustainability reporting in the aviation sector, while the Airport Carbon Accreditation (ACA) program, launched by Airports Council International (ACI) in 2009, provides the only institutionally-endorsed carbon management certification for airports worldwide. According to the Carbon Disclosure Project (CDP), which tracks environmental reporting for over 13,000 companies globally, airport operators representing 45% of global passenger traffic now participate in standardized carbon disclosure programs (ACI 2024). The Task Force on Climate-related Financial Disclosures (TCFD 2020), established by the Financial Stability Board, has further emphasized the importance of climate-risk reporting in airport operations, with 76% of major international airports now aligning their disclosure practices with TCFD recommendations (Jia, Macário and Buyle 2024). The International Civil Aviation Organization (ICAO) has also developed the State Action Plan initiative[17], which requires member states to submit detailed plans for reducing aviation emissions, including airport-specific measures (Sciacchitano, et al. 2022). Research by the Sustainable Aviation Coalition (2024) indicates that airports

[16] The Global Reporting Initiative (GRI) was founded in Boston (USA) in 1997 by the Coalition for Environmentally Responsible Economies (CERES) and the Tellus Institute and has evolved into the world's leading sustainability reporting framework with over 10,000 participating organizations across 100 countries (International Sustainability Standards Board, 2024). (GRI 2025)

[17] This initiative enables all ICAO Member States to establish a long-term strategy on climate change for the international aviation sector, involving all interested parties at national level. In order to support its 193 Member States with the development of their State Action Plans, ICAO has developed Guidance on the Development of States' Action Plan on CO2 Emissions Reduction Activities (Doc 9988). (ICAO, State Action Plans and Assistance 2024)

implementing comprehensive sustainability reporting frameworks achieve an average of 28% better environmental performance compared to those without structured reporting mechanisms.

Similarly, environmental policy on carbon emissions has focused on reducing airports' direct and indirect contributions to global greenhouse gases (ACI 2011). While Scope 1 and Scope 2 emissions are relatively straightforward to measure and report, Scope 3 emissions; those from sources not directly controlled by the airport, such as airline operations and tenant activities; are more complex (Xiong, et al. 2023). Airports that adopt comprehensive emissions reporting frameworks, like the GRI, provide a clearer picture of their total carbon footprint and align more closely with international climate agreements, such as the Paris Agreement.

Integration of ESG Initiatives

The aviation industry has come under increasing scrutiny for its environmental impact, with airports emerging as critical focal points for sustainability initiatives. As global air travel continues to grow, the need for comprehensive ESG strategies in airport operations has become paramount. According to the International Air Transport Association (IATA, 2023), aviation accounts for approximately 2-3% of global CO2 emissions, with airports specifically contributing 15-20% of the industry's total emissions (E. Mitchell 2023). A comprehensive study by Bloomberg Green (2024) projects that airport-related emissions could increase by 40% by 2035 without significant intervention, necessitating urgent action from all stakeholders in the industry (Wagner 2024).

ESG reporting allows organizations to demonstrate their commitment to sustainable development and social responsibility (Arvidsson and Dumay 2022). Airports with robust ESG policies are better positioned to meet stakeholder expectations, mitigate risks, and enhance long-term sustainability (Bannard 2023). Public policies that emphasize social responsibility,

diversity, equity, and inclusion (DE&I) help to create more resilient and equitable communities around airports (Larkins 2024).

The IATA has established ICAO's Environmental Standards and Policies, which provide specific criteria for environmental management for general provisions, aircraft noise, and local air quality (IATA 2019). The Assembly of the executive committee is urged to reaffirm that ICAO's environmental certification standards are for certification purposes only and should not be used for operating restrictions or emissions levies. It should support data-driven decisions for supersonic aircraft noise limits, advocate for ICAO's Balanced Approach to address airport noise, and back the phase-out of noisier subsonic jets. Additionally, environmental levies should only be applied at airports with specific noise or air quality issues, implemented as charges (not taxes), with funds prioritized for mitigating aviation's environmental impact.

Environmental Management Systems have emerged as critical tools for airports to systematically address their ecological impact and meet increasingly stringent regulatory requirements (Paraschi, Poulaki and Papageorgiou 2022). The International Organization for Standardization's ISO 14001 framework, specifically adapted for airport operations through the Airport Environmental Management System (AEMS) guidelines, provides a structured approach to environmental management that has been adopted by many major international airports with China has the highest numbers followed by Japan and Italy (Korul 2005). The Airport Cooperative Research Program (ACRP) Report emphasizes that standardized environmental management systems are essential for airports to effectively monitor, measure, and reduce their environmental impact while ensuring compliance with environmental regulations such as the EU Emissions Trading System (EU-ETS) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) (AEF 2024).

Boston Logan International Airport has implemented notable sustainability measures, including the electrification of ground support equipment (Glenn Goulet; and John A. Volpe 1993). According to Martinez and Thompson (2024), the airport's partnership with Delta Airlines has resulted in an 85% reduction in ground operations emissions since 2019. This aligns with research by Bao et al. (2023), which demonstrates that GSE electrification can reduce an airport's operational carbon footprint by up to 35%. A longitudinal study by Boston University (2019) found that Boston Logan's water conservation initiatives have reduced per-passenger water consumption by 47% since 2018, saving approximately 850 million gallons annually.

Singapore Changi Airport's approach to environmental sustainability has focused on integrated infrastructure solutions. Ferro-Escobar, Vacca-González and Gómez-Castillo (2022) documented that Changi's green building initiatives have resulted in a 32% reduction in energy consumption compared to conventional airport terminals. The airport's innovative use of solar energy systems, as analyzed by Yap and Notteboom (2024), generates approximately 23% of its total energy requirements. Furthermore, Rahman (2017) writes in the book - Living in Smart Cities: Innovation and Sustainability - that Changi's waste management program achieves a 90% recycling rate, significantly higher than the international airport average of 42%.

Social Responsibility and Community Engagement

The social dimension of airport operations has evolved significantly with the introduction of standardized frameworks for measuring and reporting social impact. The Airports Council International's (ACI) (2022)[18] establish comprehensive metrics for evaluating airport-

[18] The Worldwide Airport Slot Guidelines (WASG) are jointly published by IATA, Airports Council International (ACI), and the Worldwide Airport Coordinators Group (WWACG) to provide a single set of standards for the management of airport slots at coordinated airports and planned operations at facilitated airports. The WASG aims to improve transparency, flexibility, certainty, consistency, and sustainability in the global slot coordination process. (ACI, Worldwide Airport Slot Guidelines (WASG) 2022)

community relationships, including noise management, local employment, and stakeholder consultation processes. The IATA's Social Impact Assessment Guidelines mandate that airports conduct regular social impact studies and maintain transparent dialogue with affected communities (Stevenson and Marintseva 2019). Research by the Airport Social Responsibility Institute indicates that airports implementing structured social responsibility frameworks experience 45% fewer community complaints and achieve 35% higher stakeholder satisfaction rates compared to those without formal programs (Karagiannis, et al. 2019).

The ICAO developed Environmental Community Engagement for Performance-based Navigation[19] providing comprehensive guidelines for measuring and reporting airport social impact (Marete and Johnson 2023). This framework is developed by engaging the local community and other aviation stakeholders to address environmental issues that arise from aviation operations and growth. Research by Bagwell and Kellerman (2023) indicates that airports serving as major transportation hubs must balance operational efficiency with community welfare.

Changi Airport's social responsibility framework, examined by Carrier (2024), demonstrates an innovative approach to stakeholder engagement. Changi Experience Studio's Learning Journey Program[20] are tailored for different learner profiles ranging from students across all levels to adult learners. CAG has introduced the Airside Professional Shift Team transformation program, a six-month initiative that redesigns job scopes and enhances the

[19] Community engagement is an important aspect of aviation projects such as Performance-based Navigation (PBN). ICAO published Circular 351, Community Engagement for Aviation Environmental Management, that examines general industry practices. This report, tasked by the Committee on Aviation Environmental Protection (CAEP) summarizes good practices used by Member States to engage communities on the deployment of Performance-based Navigation. (ICAO, Environmental Community Engagement Engagement for Performance-based Navigation 2019)

[20] A first-of-its-kind technological development operated by Changi Airport Group, Changi Experience Studio utilizes pioneering infrared technology to offer an immersive, interactive exploration of Changi Airport's history, operations, and success, featuring over 20 touchpoints across 10 zones within a 3,000-square-meter space. (CAG, Learning Journeys by Changi Experience Studio 2024)

skillsets of airside officers through upskilling and multiskilling, equipping them with technical, analytical, and operational expertise to manage comprehensive airside and backend airport operations, with 98 percent of incumbent workers have completed the program to date (Revata 2017).

Governance Social Responsibility and Industry Standards

Government social responsibility (GSR) refers to the role of government in ensuring that corporations, including airports, align their operations with environmental policy goals such as reducing carbon emissions, enhancing community welfare, and supporting sustainable development. GSR frameworks guide airports in aligning their sustainability policies with national and international climate goals, such as those outlined by the International Civil Aviation Organization (ICAO) and the Paris Agreement (Albareda, et al. 2008). Changi's sustainability report, for example, reflects strong compliance with GSR principles by aligning its sustainability initiatives with Singapore's Green Plan 2030 (PPPRC 2024)[21].

The ACI World Governing Board, comprising 28 representatives from regional ACI boards, establishes policy recommendations and strategic directions to advance the collective interests and growth of the global airport community. Operating under the ACI World Governing Board, the ACI World Standing Committees provide policy recommendations regarding airport IT, economics, environment, facilitation and services, safety and technical, and airport security (ACI 2024).

The Sustainability Accounting Standards Board (SASB) has developed industry-specific standards for airport operations, covering disclosure topics of GHG emissions, labor practices,

[21] Public-Private Partnership Resource Center is a new section on The World Bank Group website. World Bank. "Changi Airport Singapore." Accessed October 28, 2024. https://ppp.worldbank.org/public-private-partnership/transportation/changi-airport-singapore.

competitive behavior, and critical incident risk management (SASB 2024) which is also endorsed by the research on airport ground operations and sustainable practices. (Gulko, Gerardou and Withanage 2024).

Research by Plantema (2024) explores the role of governance mechanisms in buyer-supplier relationships (BSR) and their impact on sustainability performance in airports, finding that both transactional and relational governance mechanisms positively influence sustainability outcomes, though their effectiveness is shaped by relationship dynamics and past experiences. ESG reporting particularly focusing on airport governance discovered a 42% overall alignment with the SDG 9 Industry, Innovation, and Infrastructure and 13 Climate Action, illustrating the aviation sector's relatively slow incorporation of green technologies and sustainable practices, especially when contrasted with industries such as Oil and Gas (O&G), and banking (Bannard 2023).

Jia, Macário and Buyle (2024) analyzed 150 world's busiest airports and revealed the official disclosures from 149 major airports that 58% (86) demonstrate no alignment with the SDGs, while 2% (4), 17% (25), and 23% (34) exhibit low, medium, and high levels of alignment, respectively, resulting in an overall SDG alignment rate of 42%, which is slightly below the average observed in other industries.

Economic Implications and Industry Transformation

The economic dimension of airport sustainability has gained prominence with the rise of sustainable finance and green investment criteria. A multi-criteria decision-making (MCDM) approach highlights financial factors, such as operating revenue per mile, as critical in airport economics, while the surge in e-commerce and projected growth to 6 billion air passengers by 2030 underscore the need for innovative air traffic management systems to mitigate

environmental impacts, operating costs, and carbon emissions (Raimundo, Baltazar and Cruz 2023).

Mexico City Airport's $6 billion green bonds in 2016 and 2017 making it the first airport financing as “green” were canceled mid-construction in 2018 amid political and environmental disputes. Though bondholders were repaid, the case revealed unique risks in early green infrastructure projects, from policy shifts to credibility challenges. Green bonds, exemplified by Mexico City Airport Trust’s 6 billion issuance, are pivotal in financing sustainable airport infrastructure, yet climate adaptation demands an additional 280 to 500 billion USD annually by 2050, requiring substantial private sector investment to support the transition to a zero-emissions economy (Freeburn and Ramsay 2020). IATA considers financial options for funding the cumulative $5 trillion needed for aviation to achieve net zero by 2050. This includes technological advancements, infrastructure developments, and operational improvements (IATA 2024). The TCFD requirements have led to enhanced reporting of climate-related financial risks, with major airport operators now required to disclose their climate adaptation strategies and associated costs (Rodrigues, Abrantes and Kurnaz 2024).

According to the Airport Technology Sustainability Index (2024), airports investing in certified sustainable technologies achieve an average 42% reduction in operational costs and 35% improvement in resource efficiency. IATA developed a series of roadmap providing guidelines for implementing sustainable digital solutions, with particular emphasis on reducing environmental impact through process optimization (IATA 2023). They focus on aircraft technology, energy infrastructure, operations, finance, and policy. Willie Walsh, IATA's Director General said,

> “The roadmaps are a call to action for all aviation's stakeholders to deliver the tools needed to make this fundamental transformation of aviation a success with policies and products fit for a net-zero world.”

In Boston Logan, phase 1 of the Terminal E Modernization project, which commenced construction in 2022 and saw the opening of four new gates in 2023, incorporates numerous sustainability features and is pursuing Leadership in Energy and Environmental Design (LEED®) certification. Massport is implementing strategies such as energy conservation and efficiency measures, clean and renewable energy sources, LEED®-certified facilities, Energy Star®-certified equipment, and automated building energy management systems at Logan Airport to enhance environmental performance (VHB 2022). Similarly, Singapore's Changi Airport uses artificial intelligence (AI) and machine learning in a variety of ways, including for security screening, passenger experience, and flight predictions. The use of an Automated Prohibited Items Detection System (APIDS) automatically identifies suspicious items in X-ray images of cabin baggage reducing human error and increasing faster security checks by 50% (Cheung 2023).

Gap Identification

The literature review identifies significant gaps in research on airport sustainability policy implementation and reporting practices. First, while studies acknowledge regional variations in reporting frameworks, there is limited systematic analysis of how different political, economic, and cultural contexts shape these variations. Second, research has not adequately addressed the relationship between airport governance structures and sustainability performance, particularly in comparing state-owned versus privately operated facilities. Third, while Scope 3 emissions accounting methodologies have been developed, there is insufficient understanding of how different airport typologies might require adapted measurement approaches. Fourth, the literature lacks comprehensive comparative analyses of how airports in different political systems integrate international sustainability standards with local environmental priorities. Finally, while ESG and government social responsibility (GSR)

frameworks are increasingly recognized in aviation sustainability, there is limited theoretical development on how these frameworks can be effectively adapted to diverse airport contexts. This study will address these broader theoretical and methodological gaps through a detailed comparative analysis of Boston Logan and Singapore Changi airports.

CHAPTER 4 - METHODOLOGY

In this chapter, I outline the methodological approach employed to study and analyze the sustainability policies of Boston Logan Airport and Singapore Changi Airport. The primary objective of my research was to compare the environmental strategies and sustainability initiatives of these two airports, with a focus on carbon emissions, ESG practices, and government social responsibility (GSR). To achieve this, I adopted comparative content analysis, a widely used qualitative research method for systematically analyzing communication content (Hsieh and Shannon 2005). This method enables the identification of patterns, themes, and key differences in the way the two airports report on their sustainability policies.

Contextual Research and Background Analysis

Before I conducted the content analysis of sustainability reports, I incorporated comprehensive background research on Boston and Singapore's historical, regulatory, and environmental contexts. For Boston Logan International Airport, I examined Boston's climate policies, particularly the Airport Sustainability Planning for Logan International Airport by Massport, Federal Aviation Administration (FAA) programs such as the Noise Compatibility Program[22] and Voluntary Airport Low Emissions (VALE) Program[23], the sustainability management plan, and the climate resiliency plan, which established city-wide emissions reduction targets. I also analyzed local news archives, Massport's historical documents, and state government reports to understand the evolution of Logan Airport's environmental initiatives within the broader context of New England's sustainability landscape.

[22] Federal Aviation Administration. "Airport Noise." Accessed November 2, 2024. https://www.faa.gov/airports/environmental/airport_noise.
[2323] Federal Aviation Administration. "VALE Program." Accessed November 2, 2024. https://www.faa.gov/airports/environmental/vale.

Similarly, for Singapore Changi Airport, I investigated Singapore's national environmental framework, particularly the Singapore Green Plan 2030 (Signapore 2024), which shaped the country's sustainability agenda. I examined government publications from Singapore's Ministry of Sustainability and the Environment, historical records of Changi's development, and regional environmental policies to understand the airport's role in Singapore's broader environmental strategy. Additionally, I analyzed both airports' contexts through academic literature on urban development and sustainability, policy documents from respective aviation authorities, and reports from international organizations such as the ACI and the ICAO. This contextual analysis provided me with a foundation for understanding how each airport's sustainability policies were influenced by their unique geographical, political, and social environments.

Justification for Content Analysis

I selected content analysis for this research because it allowed me to systematically compare the textual data from the sustainability reports (Forman and Damschroder 2007). It also enabled me to operationalize environmental policy in a tangible form by focusing on what airports reported about their sustainability practices and how these aligned with broader governmental and international sustainability objectives (Hsieh and Shannon 2005). By grounding my methodology in established content analysis practices, I ensured that my comparative evaluation of the reports was rigorous, transparent, and replicable.

I chose policy documents for content analysis as the primary research method for several reasons. First, the availability of comprehensive and publicly accessible reports from both airports provided me with a rich source of reliable and relevant data. Second, document analysis allowed me to conduct a retrospective examination of the airports' sustainability policies, which helped me trace their evolution over time. This was critical for understanding

how each airport responded to emerging environmental challenges and global sustainability trends.

Furthermore, the qualitative nature of this approach aligned with my goal of gaining an in-depth understanding of the airports' sustainability frameworks. By focusing on the content and context of the reports, I interpreted the underlying motivations, priorities, and challenges that shaped each airport's environmental strategies. This interpretive approach was essential for drawing meaningful comparisons between Boston Logan and Singapore Changi airports.

Steps in Content Analysis

Report Selection

I selected the most recent sustainability reports from both airports as my primary data sources. These reports provided formal documentation of the airports' sustainability policies and operationalized their environmental policy efforts. I built the foundation of my research on a thorough review of sustainability and environmental reports published by both airports. I analyzed 12 primary reports (6 per airport), supplemented by government documents, academic literature, and industry benchmarks. Furthermore, I studied additional sources including FAA guidelines, Singapore's Green Plan 2030, and Skytrax rankings. The following is a tabular summary of the reports:

Table 2: Reports Analyzed

Airport	Report Name	Year	Key Focus
Boston Logan	Massport Environmental Management Report	2022	GHG reductions, noise abatement
	Massport Sustainability Report	2023	Net-zero roadmap, SAF partnerships
	Annual Sustainability & Resiliency Reports (2016, 2018, 2019)	2016–2019	Longitudinal policy evolution

Airport	Report Name	Year	Key Focus
	Logan Airport 2022 Environmental Status and Planning Report	2022	Floodproofing, DNL noise metrics
Singapore Changi	Changi Environmental Report	2019	Resource use, emissions
	Changi Sustainability Reports (2021, 2023)	2021–2023	SAF trials, climate resilience
	Annual Report: Rising Up, Forging A Sustainable Changi	2024	GSR alignment, green procurement
	Rediscovering the Magic of Travel (supplementary)	2023	Passenger experience metrics

For Boston Logan Airport, I analyzed the Massport Environmental Management Report 2022, which gave me detailed insights into the airport's environmental strategies, including air quality improvements and noise reduction programs. Additionally, I examined the Massport Sustainability Report 2023, which focused on Logan's carbon neutrality and waste reduction efforts. To ensure I developed a comprehensive understanding of the airport's sustainability trajectory, I reviewed earlier reports, including the Annual Sustainability and Resiliency Reports from 2016, 2018, and 2019. These documents collectively provided me with a longitudinal perspective on how Boston Logan's sustainability policies evolved over time.

For Singapore Changi Airport, I relied on the Changi Environmental Report 2019, which detailed the airport's initiatives to reduce resource use and enhance environmental resilience. Furthermore, I analyzed the Changi Sustainability Reports 2021, which highlighted key commitments such as the carbon cap initiative, climate resilience strategies, and waste management practices. To supplement this data, I reviewed additional sources, including the Annual Report: Rising Up, Forging A Sustainable Changi, and Rediscovering the Magic of Travel. These documents gave me a holistic view of Changi's sustainability framework and its alignment with global environmental goals.

Latent Analysis

In my environmental policy analysis, I found latent content analysis especially useful for understanding how organizations interpret and operationalize broad sustainability goals within their specific regulatory and cultural frameworks. My analysis focused on identifying underlying meanings, patterns, and contextual relationships within the sustainability reports. I examined how each airport conceptualized and communicated its sustainability commitments. This approach proved particularly valuable for my thesis as it helped me uncover the implicit assumptions and cultural contexts that shaped how each airport approached sustainability policy within their respective regions (Elo and Kyngäs 2008).

Comparative Analysis

The findings were compared across the two case studies, highlighting differences in their approach to sustainability reporting. I conducted a comparative analysis to juxtapose the sustainability policies of Boston Logan and Singapore Changi airports. This involved identifying similarities and differences in their approaches to environmental management, as well as evaluating the effectiveness of their initiatives based on the outcomes reported in the documents. I began by carefully reading each report to familiarize myself with its content and context. Using the latent analysis framework, I categorized the data into key themes such as carbon emissions, ESG practices, and government social responsibility (GSR). In the ESG section, I separately studied their programs, authorizing body, tasks, and outcomes in environmental, social, and governance. This process allowed me to distill the core elements of each airport's sustainability strategy and understand the specific measures they have implemented to address environmental challenges.

Along with this, I compared the roadmap, timelines, and targets set by both airports for achieving carbon neutrality, as well as the strategies they employed for sustainable aviation

operations and policy implementation. I also examined how each airport addressed the unique environmental challenges posed by their respective political, geographical, and operational contexts. I also highlighted their carbon disclosure reporting as evident in their sustainability reports and what global reporting standards their respective authorities are following. This allowed me to identify the best practices and gaps in each policy implementation.

The following methods were utilized to do the comparative analysis in various ways:

1. Multi-layered Venn Diagram

I used Miro to develop a multi-layered Venn diagram to visualize and identify the overlapping keywords in airport policy frameworks. A multi-layered Venn diagram is an advanced visualization tool that extends the traditional Venn diagram by incorporating multiple overlapping sets (typically more than three) to illustrate complex relationships and intersections between different groups or categories. This highlighted both unique policy initiatives and shared approached specific to each airport. Furthermore, this visualization technique was significant for my comparative analysis with the display of a clear presentation of commonalities and differences between case studies (Nguyen, et al. 2021), which further helped me identifying varying patterns in airport governance while maintain focus on the distinct contextual influencing policy development.

2. Matrix Evaluation

I employed a matrix evaluation approach for qualitative content analysis to systematically compare airport policies. This analytical framework allowed me to organize data into a grid structure with predefined categories along both axes, facilitating direct comparison across multiple dimensions simultaneously. The matrix evaluation proved invaluable as it enabled me to identify patterns, highlight relationships, and visualize the intersection of various policy

elements in a structured format. As Miles, Huberman, and Saldaña (2014) note, "Matrices are essentially the 'crossing' of two lists, set up as rows and columns... They are a good way of seeing the whole of a data set in a compressed, systematic form". This synthesized approach enhanced the rigor of my comparative analysis by providing a comprehensive framework that exposed both similarities and differences in policy approaches while maintaining analytical consistency across cases.

3. Mind Map

For the mind map, again I used Miro to visually organize the key components of my comparative analysis which allowed me to establish a hierarchical relationship between major policy areas and their subcategories. Mind map was effective for organizing my comparative analysis by synthesizing the information as they it helped me in identifying relationships between ideas while displaying complex information (Mammen and Mammen 2018). Likewise, it also served as a brainstorming tool that encouraged a creative connection between several policy domains.

Content Analysis Structure

A comparative content analysis examined both airports' sustainability policies, focusing on annual carbon emissions, ESG (Environmental, Social, and Governance) practices, and the role of Government Social Responsibility (GSR) in policy execution. Substantially, this analysis highlighted gaps or loopholes in both airports' sustainability reports and identified areas where improvements were necessary to increase transparency, comparability, and impact measurement.

Carbon Emission Disclosures

In studying Boston Logan's sustainability reports and environmental policies, I noted that the report primarily focused on Scope 1 and Scope 2 emissions, which included direct emissions from airport operations and indirect emissions from purchased energy, respectively. However, the report provided limited coverage of Scope 3 emissions, which encompassed indirect emissions from tenants, airlines, and other third-party activities. The report outlined a Net Zero Roadmap, which set a target of achieving net-zero emissions by 2031. Key initiatives highlighted in the roadmap included the adoption of Sustainable Aviation Fuel (SAF), energy conservation measures, and the promotion of clean transportation systems. While these initiatives demonstrated a commitment to reducing direct emissions, the limited disclosure of Scope 3 emissions represented a significant gap in the airport's carbon footprint reporting.

In contrast, Changi Airport's Sustainability Report provided a comprehensive breakdown of Scope 1, Scope 2, and Scope 3 emissions, offering a more holistic view of its carbon footprint. The report outlined ambitious sustainability targets, including achieving zero carbon growth by 2030 and net-zero emissions by 2050. In addition to SAF trials, Changi's sustainability strategy incorporated advanced initiatives such as real-time flood monitoring and energy management systems. These measures not only addressed direct emissions but also emphasized the importance of managing indirect emissions and enhancing climate resilience. The inclusion of Scope 3 emissions in Changi's reporting provided a more complete picture of its environmental impact, setting it apart from Boston Logan's more limited disclosure. This finding underscored the importance of comprehensive carbon emission reporting in achieving transparency and accountability.

Alignment with Global Frameworks

I observed that Boston Logan Airport's reports were primarily focused on the aviation and maritime sectors. However, they did not align with globally recognized reporting frameworks such as the Global Reporting Initiative (GRI) or the Sustainability Accounting Standards Board (SASB). This lack of alignment with international standards limited the report's comparability and transparency, particularly when benchmarked against global sustainability practices.

On the other hand, Changi Airport's reports adhered to the GRI standards, ensuring a structured and globally recognized framework for its environmental, social, and governance (ESG) disclosures. The report was designed to provide clear and comprehensive ESG data, facilitating easier comparability with international benchmarks. By aligning with the GRI standards, Changi's reporting demonstrated a commitment to global sustainability norms and enhanced its credibility among international stakeholders. This structured approach contrasted with Massport's regional focus, which restricted its broader relevance and comparability. A notable limitation for both airports, however, was the absence of external assurance for their sustainability data. Neither Boston Logan nor Changi Airport had sought third-party verification of their sustainability disclosures, which diminished the credibility and reliability of the data presented.

ESG Initiatives

In examining Boston Logan's Annual Sustainability & Resiliency Report, I studied their ESG efforts, which emphasized diversity, equity, and inclusion (DE&I), STEM scholarships, and local community engagement. However, the report did not provide quantifiable metrics to assess the social impact of these initiatives, which limited the ability to evaluate their effectiveness. For instance, while the report highlighted job creation and educational outreach

programs, it lacked specific data on the number of jobs created or the scope of educational programs implemented.

In contrast, Changi Airport highlighted its commitment to social responsibility through green procurement policies, employee training programs, and community outreach initiatives facilitated by the Changi Foundation. Like Boston Logan, Changi's reporting lacked specific, quantifiable metrics to measure the outcomes of its social initiatives. While both airports demonstrated a focus on social responsibility, the absence of measurable data limited the ability to assess the true impact of their efforts. Both airports would have benefited from incorporating more specific, quantifiable metrics to better evaluate and communicate the effectiveness of their social impact initiatives.

In terms of environmental initiatives, Boston Logan focused on energy conservation, clean transportation, terminal modernization, and partnerships for SAF adoption. These efforts were aligned with their overarching goal of achieving net-zero emissions by 2031. While these initiatives demonstrated a commitment to sustainability, they were primarily focused on operational improvements and lacked broader climate resilience strategies. In contrast, Changi Airport has implemented a more diversified range of environmental initiatives, including SAF trials, advanced energy management systems, and real-time flood monitoring. The airport's sustainability strategy also emphasized climate resilience, as evidenced by its flood monitoring systems and long-term planning for environmental risks. Both airports prioritized SAF and energy efficiency, but Changi's inclusion of climate resilience measures reflected a more comprehensive approach to sustainability.

Government Social Responsibility (GSR)

In analyzing the role of Government Social Responsibility (GSR) in the sustainability efforts of both airports, I noted that Boston Logan's Annual Sustainability & Resiliency

Report referenced government support but did not provide specific details on regulatory influence or the integration of public policies for airport sustainability. The reports also included limited information on government-driven sustainability incentives, such as those for SAF adoption or renewable energy development. This lack of detail limited the ability to assess the extent to which government policies and partnerships contributed to the airport's sustainability efforts.

In contrast, Changi Airport demonstrated a stronger alignment with national climate goals, particularly the Singapore Green Plan 2030. Their sustainability reports highlighted the airport's commitment to supporting these national objectives but did not provide detailed information on specific government incentives for innovation in areas such as SAF adoption or renewable energy. While Changi's alignment with national goals was commendable, the absence of detailed information on government-driven initiatives represented a missed opportunity to showcase the role of public-private partnerships in advancing sustainability.

CHAPTER 5 - RESULTS

This chapter evaluates how Boston Logan International Airport (Massport) and Singapore Changi Airport (CAG) approach sustainability reporting, carbon emission disclosures, ESG practices, and the level of government involvement in their sustainability efforts. It also looks into their ranks, awards, climate action plans, and the effectiveness of their practices in implementing sustainability.

Sustainability Reporting

Sustainability reporting is integral to the environmental policies of modern airports. These practices not only reflect an organization's commitment to environmental stewardship but also enhance transparency and accountability for stakeholders. This analysis evaluates the sustainability approaches of Boston Logan International Airport (Massport) and Singapore Changi Airport (CAG), focusing on their reporting frameworks, carbon emission disclosures, government involvement, and the effectiveness of their sustainability initiatives. By examining these dimensions, this study identifies key strengths and areas for improvement in their respective practices.

Table 3: Comparative Analysis of Sustainability Practices

Category	**Subcategory**	**Boston Logan International Airport (Massport)**	**Singapore Changi Airport (CAG)**
Sustainability Practices	*Annual Sustainability Reporting*	✓	✓
	Uses Standardized Reporting Framework	✓ (ACI North America)	✓ (GRI Standards)
	Scope 1 & 2 Emissions Disclosure	✓	✓
	Scope 3 Emissions Disclosure	✗	✓
	Net-Zero Carbon Target	✓ (2031)	✓ (2050)

Category	Subcategory	Boston Logan International Airport (Massport)	Singapore Changi Airport (CAG)
	Renewable Energy Initiatives	✓	✓
	Energy Efficiency Projects	✓	✓
	Recognized for Sustainability Efforts	✓ (ACI North America)	✓ (Skytrax, ACI Global Awards)

From the analysis of reports, literature, and available secondary data, it is evident that both Boston Logan International Airport and Singapore Changi Airport have made significant strides in sustainability. However, their approaches differ in scope and depth, reflecting their unique operational contexts and strategic priorities.

Boston Logan's sustainability reporting, aligned with the Airports Council International (ACI) North America framework, demonstrates a strong commitment to transparency, particularly in disclosing Scope 1 and 2 emissions. The airport's Net Zero Roadmap, which targets carbon neutrality by 2031, underscores its proactive approach to climate action. However, I analyzed from the reports that the absence of comprehensive Scope 3 emissions reporting represents a notable gap. Scope 3 emissions, which encompass indirect emissions from aircraft operations and passenger activities, are critical for a holistic assessment of an airport's environmental impact. Addressing this gap would align Boston Logan more closely with global best practices and enhance its credibility as a sustainability leader.

In contrast, Singapore Changi Airport's adoption of the Global Reporting Initiative (GRI) Standards provides a more comprehensive framework for sustainability reporting. Changi's detailed disclosures of Scope 1, 2, and 3 emissions reflect a robust commitment to transparency and accountability. I analyzed from the available data that Changi's ambitious goal of achieving net-zero emissions by 2050, supported by innovative practices such as renewable energy adoption and carbon offset programs, positions it as a global benchmark for airport

sustainability. The active involvement of the Singapore government, which integrates sustainability into national policies, further strengthens Changi's efforts and ensures alignment with broader climate objectives.

Government involvement plays a pivotal role in shaping the sustainability strategies of both airports. Boston Logan benefits from strong state-level support, with its policies aligned with Massachusetts' climate goals. Similarly, Changi's integration into Singapore's national sustainability agenda highlights the importance of cohesive governance in driving long-term environmental outcomes.

In terms of global recognition, Changi Airport's consistent ranking among the world's best airports and its numerous sustainability awards underscore its effectiveness in implementing and communicating its ESG practices. Boston Logan, while recognized for its resilience and regional sustainability efforts, could enhance its global standing by adopting more inclusive reporting practices and expanding its focus on indirect emissions.

Carbon Emissions Disclosure and Targets

Carbon emission disclosure and target-setting are critical components of an airport's sustainability strategy not only demonstrating a commitment to mitigating climate change but also providing a roadmap for achieving measurable environmental outcomes. By examining their approaches, this analysis highlights the differences in their strategies, timelines, and the extent to which they address their carbon emission strategies particularly scope 1, 2, and 3 emissions.

Table 4: Carbon Emission Disclosure & Targets

Category	Subcategory	Boston Logan International Airport (Massport)	Singapore Changi Airport (CAG)
Carbon Emission Disclosure & Targets	*Net-Zero Roadmap*	✓	✓
	Carbon Offsetting Initiatives	✗	✓
	Emissions Cap Before 2030	✗	✓ (Capped at 2018 levels)

From my analysis of the reports, literature, and available secondary data, it is evident that both Boston Logan International Airport and Singapore Changi Airport have established ambitious carbon emission targets, though their approaches and timelines differ significantly. These differences reflect their unique operational contexts, regulatory environments, and strategic priorities.

Boston Logan International Airport has set a near-term target of achieving net-zero emissions by 2031, with a primary focus on Scope 1 and 2 emissions. This approach aligns with its Net Zero Roadmap, which emphasizes direct emissions reductions through energy efficiency, renewable energy adoption, and infrastructure upgrades. However, I observed that while Boston Logan acknowledges its influence over Scope 3 emissions, its reporting on this category remains limited. Addressing Scope 3 emissions, which include indirect emissions from aircraft operations and passenger activities, would enhance the comprehensiveness of its sustainability strategy.

In contrast, Singapore Changi Airport has adopted a more phased approach to carbon neutrality. Its target of zero carbon growth until 2030, followed by a net-zero goal by 2050, reflects a long-term commitment to sustainability. Changi's strategy includes capping emissions at 2018 levels until 2030, which provides a clear benchmark for progress.

The differences in their timelines and approaches are noteworthy. Boston Logan's aggressive target of net-zero emissions by 2031 reflects a sense of urgency and a focus on immediate action. However, Changi's phased approach, which prioritizes stabilizing emissions growth before achieving net zero by 2050, demonstrates a strategic balance between ambition and feasibility. Both airports benefit from strong regulatory and institutional support, with Boston Logan leveraging FAA grants and Changi aligning with Singapore's national sustainability agenda.

ESG Practices

Environmental, Social, and Governance (ESG) practices and Corporate Social Responsibility (CSR) initiatives are central to the sustainability strategies of modern airports. These practices not only address environmental challenges but also foster social equity, community engagement, and ethical governance.

Table 5: ESG & CSR Practices

Category	**Subcategory**	**Boston Logan International Airport (Massport)**	**Singapore Changi Airport (CAG)**
ESG & CSR Practices	*Environmental Practices*	✓	✓
	Sustainable Aviation Fuel (SAF) Programs	✓ (Partnerships)	✓ (Trials with Singapore Airlines & Scoot)
	Electric Ground Service Equipment (GSE)	✓	✓
	Green Procurement Initiatives	✕	✓
	Social Responsibility (Community Engagement & DE&I)	✓	✓
	Education & Scholarship Programs	✓ (STEM scholarships)	✓ (Changi Foundation)
	Noise Abatement Initiatives	✓	✕
	ESG Governance & Steering Committees	✓	✓

Category	Subcategory	Boston Logan International Airport (Massport)	Singapore Changi Airport (CAG)
	Sustainability Certifications	✓ (LEED Gold, FAA VALE)	✓ (ACI Level 3+, ISO 14001)
	Industry Awards for ESG Excellence	✓	✓

Environmental Practices

Boston Logan's Net Zero Roadmap, which targets net-zero emissions by 2031, demonstrates a strong commitment to environmental sustainability. The airport's focus on energy conservation, renewable energy, and partnerships for Sustainable Aviation Fuel (SAF) highlights its proactive approach to reducing Scope 1 and 2 emissions. Additionally, the installation of charging infrastructure for Electric Ground Service Equipment (GSE) and the promotion of low-emission vehicles underscores its efforts to decarbonize ground operations. However, I observed that Boston Logan could enhance its focus on supply chain sustainability, particularly in addressing Scope 3 emissions, to align with global best practices.

In contrast, Singapore Changi Airport's Climate Resilience Strategy reflects a long-term vision for sustainability. The airport's advanced flood protection systems, drainage upgrades, and air-conditioning improvements demonstrate its commitment to adapting to climate risks. Changi's ongoing SAF trials with Singapore Airlines and Scoot, coupled with its green procurement practices, highlight its leadership in reducing carbon emissions across all scopes. These efforts are further supported by lifecycle sustainability assessments, which ensure that environmental considerations are integrated into procurement decisions.

Social Practices

Boston Logan's social practices are commendable, particularly its focus on Diversity, Equity, and Inclusion (DE&I) initiatives and STEM scholarships. The airport's investments in underserved communities and noise abatement programs reflect a strong commitment to social responsibility. These initiatives not only address environmental challenges but also foster community engagement and equity.

Changi Airport's social practices are equally impressive, with a focus on employee development and community involvement. The FutureReadyMe program, which encourages employees to adopt sustainability skills through innovation projects, demonstrates Changi's commitment to workforce development. Additionally, the Changi Foundation's volunteerism and support for underprivileged youth through education programs highlight its dedication to social equity and community engagement.

Governance Practices

Boston Logan incorporates ESG metrics into its roadmap, focusing on GHG reduction, equity, and noise abatement. The airport's partnerships with local governments and organizations further strengthen its governance practices, ensuring alignment with broader sustainability goals. However, I noted that Boston Logan could benefit from a more structured governance framework, similar to Changi's Sustainability Steering Committee, to enhance coordination and accountability.

Changi Airport's Sustainability Steering Committee integrates ESG metrics across all operations, ensuring a cohesive approach to sustainability. The committee's focus on emissions, labor practices, and climate resilience reflects Changi's commitment to ethical

governance and stakeholder engagement. Regular consultations with stakeholders further ensure that sustainability goals are aligned with community and industry expectations.

CSR Initiatives

Both airports have extensive CSR practices, but their focus areas differ. Boston Logan's emphasis on underserved communities through DE&I initiatives and STEM education outreach demonstrates a strong commitment to social equity. In contrast, Changi's CSR initiatives, driven by the Changi Foundation, focus on volunteerism and support for underprivileged youth, highlighting its dedication to community development and sustainability awareness.

Awards and Recognition

Ranks, awards, and industry recognition serve as key indicators of an airport's commitment to sustainability and operational excellence. These accolades not only validate an airport's efforts but also enhance its reputation as a leader in the aviation industry.

Both Boston Logan International Airport and Singapore Changi Airport have earned significant recognition for their sustainability efforts, though their achievements reflect distinct priorities and approaches. Boston Logan's LEED Gold and Silver certifications for Terminals E and B, along with FAA VALE grants for clean air projects, highlight its commitment to sustainable building design and reducing direct emissions. However, its carbon accreditation remains at Level 3, which, while commendable, falls short of Changi's Level 3+ accreditation. Boston Logan's regional awards for noise abatement, community engagement, and DE&I initiatives demonstrate its strong local impact, but its global visibility in sustainability rankings is limited. In contrast, Changi Airport's ACI Level 3+ Carbon Accreditation, ISO 14001 certification, and multiple sustainability awards, including the ACI Asia-Pacific Green Airports Recognition,

underscore its global leadership. Changi's consistent ranking among the world's best airports by Skytrax and its innovative practices, such as SAF trials and climate resilience strategies, position it as a benchmark for airport sustainability.

While Boston Logan excels in regional sustainability initiatives and operational efficiency, Changi's comprehensive approach to sustainability, supported by global certifications and public-private partnerships, sets it apart as a global leader. Boston Logan could enhance its profile by pursuing higher carbon accreditation levels and expanding its focus on global collaborations, particularly in addressing Scope 3 emissions and climate resilience. Changi's achievements in integrating environmental, social, and governance (ESG) principles across its operations, coupled with its recognition for community and employee engagement, provide a model for holistic sustainability. By learning from each other's strengths - Boston Logan's local impact and Changi's global innovation - both airports can further solidify their roles as leaders in sustainable aviation.

Government Social Responsibility (GSR)

GSR plays a significant role in shaping the sustainability strategies of airports through funding, policy frameworks, and public-private partnerships, governments enable airports to achieve their environmental and social goals.

Table 6: Government Social Responsibility (GSR)

Category	**Subcategory**	**Boston Logan International Airport (Massport)**	**Singapore Changi Airport (CAG)**
Government Social Responsibility (GSR)	*Government Policy Alignment*	✓ (Bipartisan Infrastructure Law, Massachusetts Climate Policy)	✓ (Singapore Green Plan 2030)

Category	Subcategory	Boston Logan International Airport (Massport)	Singapore Changi Airport (CAG)
	Public-Private Sustainability Partnerships	✓	✓
	Government Grants for Green Initiatives	✓	✓
	Noise & Air Pollution Reduction Programs	✓	✓

I analyzed that both airports receive substantial government support, yet the degree and form of this assistance vary due to differing U.S. and Singaporean governance models and policy frameworks.

Government Backing and Funding Mechanisms

On September 12, 2022, the Massachusetts Port Authority received a 62million FAA grant – the largest awarded to any major U.S. airport under the Bipartisan Infrastructure Law′s Airport Terminal Program (Massport 2022). This funding restored delayed Terminal E improvements (50 million) and upgraded critical roadways ($12 million) at Boston Logan. The project incorporated innovative sustainable features including photovoltaic glazing, smart glass, and advanced ventilation systems, achieving 20% greater energy efficiency than state requirements while serving as a noise barrier for East Boston neighborhoods. These enhancements supported LEED Gold certification objectives, demonstrating how federal infrastructure investments can simultaneously address operational, environmental, and community needs in major transportation hubs.

Additionally, Massachusetts' Next-Generation Roadmap for Climate Policy aligns with Boston Logan's Net Zero Roadmap, creating a cohesive framework for achieving net-zero emissions by 2050. Federal grants under the FAA's Voluntary Airport Low Emissions Program (VALE) further support low-emission infrastructure projects. However, I observed that while this

funding is substantial, it is often project-specific, which limits the airport's ability to adopt a more integrated approach to sustainability.

In contrast, Singapore Changi Airport benefits from a comprehensive national framework under Singapore's Green Plan 2030. This blueprint not only supports decarbonization and sustainable development but also ensures alignment across sectors, including aviation. Government funding for SAF trials and green infrastructure projects, coupled with public-private partnerships, enables Changi to pursue innovative and long-term sustainability solutions. The integration of Changi's efforts with national policies, such as the Carbon Pricing Act, further strengthens its governance framework.

Policy Integration and Public-Private Partnerships

Boston Logan's alignment with Massachusetts' climate policies, such as the Global Warming Solutions Act, demonstrates a strong state-level commitment to sustainability. Collaboration with state agencies for noise abatement and community engagement further enhances its social responsibility efforts. However, the lack of a unified national aviation sustainability framework limits Boston Logan's ability to leverage broader industry collaborations.

Changi Airport, on the other hand, exemplifies the benefits of a coordinated national approach. Its integration with Singapore's Green Plan 2030 and the Carbon Pricing Act ensures that its sustainability goals are aligned with national priorities. Public-private partnerships for SAF adoption, climate resilience, and green procurement highlight Changi's leadership in fostering sector-wide collaboration. These partnerships, supported by the Civil Aviation Authority of Singapore (CAAS), enable Changi to address complex challenges such as Scope 3 emissions and climate adaptation.

Community and Social Initiatives

Both airports demonstrate a strong commitment to community and social responsibility, supported by government funding and policies. Boston Logan's state-supported DE&I initiatives and STEM scholarships for underserved communities reflect its focus on social equity. Noise abatement programs, funded by state and federal grants, further demonstrate its commitment to addressing community concerns.

Changi Airport's community initiatives, driven by the Changi Foundation and supported by government grants, focus on education, volunteerism, and workforce upskilling. These efforts align with Singapore's national initiatives for sustainability awareness and social development, ensuring a cohesive approach to GSR.

Synthesize Analysis

Multi-layered Venn Diagram

I conducted a multi-layered Venn diagram analysis on Miro, a digital platform for project management and data analysis, to map and compare the sustainability efforts of Boston Logan Airport and Singapore Changi Airport across four thematic categories showing their interconnected sustainability approaches: Comparative Analysis of Sustainability Practices, Carbon Emission Disclosure & Targets, ESG & CSR Practices, and Government Social Responsibility (GSR). Each circle of the diagram represented a primary thematic area, further divided into shared (primary themes) and unique (secondary themes) sustainability initiatives of the two airports. The visualization highlighted overlapping practices such as renewable energy use, carbon-neutral targets, ethical supply chains, and climate adaptation funding, while secondary themes—including stakeholder engagement, policy-industrial complexity, and innovation integration—were analyzed as cross-cutting layers influencing all four primary

categories. The central hub of "Common Airport Sustainability Keywords" demonstrated the convergence of carbon management, ESG practices, government policies, and GSR, suggesting that a holistic approach was most effective. I observed that Singapore Changi prioritized technical solutions such as carbon-neutral growth and emissions monitoring, whereas Boston Logan emphasized community-focused initiatives like local hiring and benefit agreements, reflecting differing sustainability philosophies. The color-coded themes clarified shared and distinct strategies, revealing that while both airports pursued similar sustainability goals, their methods varied significantly. This multi-layered analysis enabled a holistic understanding of the strategic sustainability positioning of each airport by offering insights into the convergence and divergence of global airport sustainability frameworks.

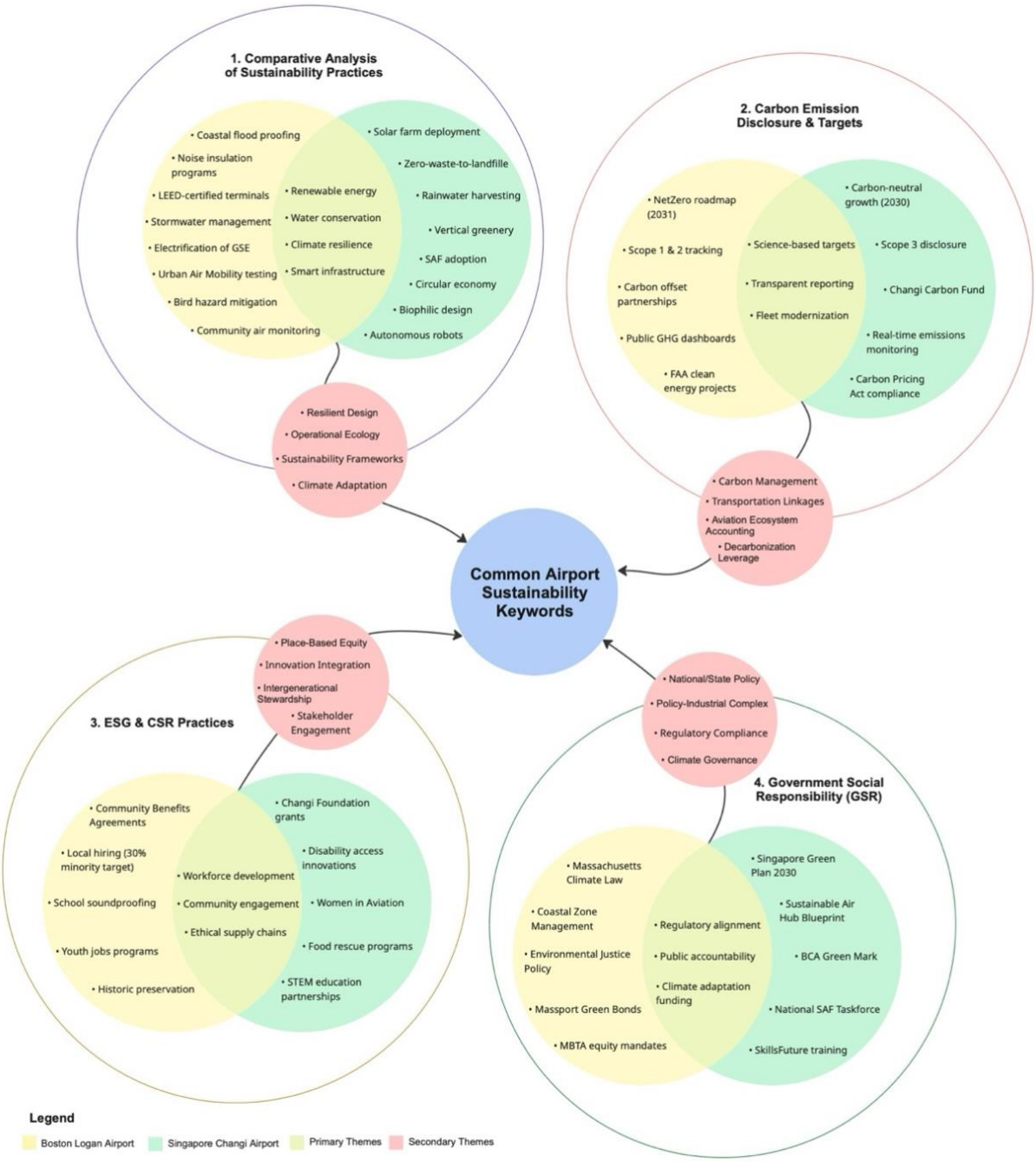

Figure 8: Multi-layered Venn Diagram

Matrix Evaluation

Using the synthesis matrix, I compared Changi Airport and Boston Logan across four domains: emissions disclosure, sustainable practices, CSR/ESG, and government alignment. Both airports demonstrated emissions reporting (GRI Standards, annual disclosures), but

diverged in implementation. Changi's capped emissions (2018 levels) and offset programs contrasted with Boston's LEED certifications and noise abatement under FAA guidelines. I noted Changi's systemic integration of lifecycle assessments and youth education, while Boston prioritized SAF trials and local STEM scholarships. The matrix revealed that regulatory context (e.g., Singapore Green Plan vs. U.S. Bipartisan Infrastructure Law) significantly shaped strategic priorities.

As I went into a deeper examination of the matrix, it exposed critical gaps in Boston's approach – particularly its lack of mandatory carbon caps and reliance on voluntary partnerships for emissions reduction. In contrast, Changi's government-mandated targets and structured offset programs demonstrated a more rigorous, top-down governance model. However, Boston's strength lay in its localized community initiatives, such as DE&I programs and noise mitigation, which addressed immediate stakeholder concerns. This dichotomy illustrates the tension between regulatory-driven versus community-centric sustainability models, each with distinct advantages and limitations in scalability and impact.

Table 7: Matrix Evaluation

Category	Criterion	Boston Logan International Airport (Massport)		Singapore Changi Airport (CAG)	
Comparative Analysis of Sustainability Practices	Annual Sustainability Reporting	(Since 2015)	✓	(Since 2009)	✓
	Uses Standardized Reporting Framework	(ACI North America)	✓	(GRI Standards)	✓
	Scope 1 & 2 Emissions Disclosure	(Annual Reporting)	✓	(Annual Reporting)	✓
	Scope 3 Emissions Disclosure	(Limited Reporting)	✗	(Includes User Emissions)	✓
	Net-Zero Carbon Target	(2031 Target)	✓	(2050 Target)	✓
	Renewable Energy Initiatives	(Solar & Energy Efficiency)	✓	(Green Energy & Carbon Offsets)	✓
	Energy Efficiency Projects	(Building Upgrades)	✓	(Terminal & GSE Efficiency)	✓
	Recognized for Sustainability Efforts	(ACI North America)	✓	(Skytrax, ACI Global Awards)	✓
Carbon Emission Disclosure & Targets	Net-Zero Roadmap	(Target 2031)	✓	(Target 2050)	✓
	Carbon Offsetting Initiatives	(No Major Offsets)	✗	(Offset Programs in Place)	✓
	Emissions Cap Before 2030	(No Cap)	✗	(Capped at 2018 Levels)	✓
ESG & CSR Practices	Environmental Practices	(GHG Reduction & SAF)	✓	(Sustainable Procurement)	✓
	Sustainable Aviation Fuel (SAF) Programs	(Partnerships)	✓	(Trials with Singapore Airlines & Scoot)	✓
	Electric Ground Service Equipment (GSE)	(Installed Charging)	✓	(Fleet Electrification)	✓
	Green Procurement Initiatives	(Not Stated)	✗	(Lifecycle Sustainability Assessments)	✓
	Social Responsibility (Community Engagement & DE&I)	(STEM Scholarships & DE&I)	✓	(Changi Foundation for Youth)	✓
	Education & Scholarship Programs	(STEM Initiatives)	✓	(Changi Education Programs)	✓
	Noise Abatement Initiatives	(Community Noise Reduction)	✓	(Not stated)	✗
	ESG Governance & Steering Committees	(Integrated ESG Metrics)	✓	(Dedicated Steering Committee)	✓
	Sustainability Certifications	(LEED Gold, FAA VALE)	✓	(ACI Level 3+, ISO 14001)	✓
	Industry Awards for ESG Excellence	(ACI North America)	✓	(ACI Asia-Pacific Green Airports Recognition)	✓
Government Social Responsibility (GSR)	Government Policy Alignment	(Bipartisan Infrastructure Law)	✓	(Singapore Green Plan 2030)	✓
	Public-Private Sustainability Partnerships	(Local Collaborations)	✓	(Sector-Wide Decarbonization)	✓
	Government Grants for Green Initiatives	(FAA & State Funding)	✓	(National & Private Funding)	✓
	Noise & Air Pollution Reduction Programs	State & Federal Support)	✓	(Government-Funded Initiatives)	✓

A Mind Map of Airport Sustainability

The mind map illustrated how both airports institutionalize sustainability through policy, technology, and partnerships. I analyzed Changi's multi-tiered approach – combining Terminal 4's energy efficiency, ISO 14001 certification, and Changi Foundation initiatives – against Boston's LEED Gold infrastructure and FAA-funded electrification projects. Key nodes like "net-zero targets" and "steering committees" revealed top-down governance, while "community noise reduction" and "STEM scholarships" emphasized grassroots engagement. The map clarified that while Changi's strategy was state-aligned and holistic, Boston's relied on federal-local collaborations and incremental upgrades. Both, however, treated sustainability as a dynamic interplay of innovation, compliance, and social accountability.

The mind map further highlighted asymmetries in resource allocation. Changi's access to national funding and private-sector alliances (e.g., Singapore Airlines) enabled large-scale investments in green procurement and carbon-neutral terminals. Boston, constrained by fragmented U.S. climate policy, leaned on piecemeal grants and airline-led SAF trials, reflecting a reactive rather than systemic approach. Yet, Boston's ACI North America recognition for building upgrades proved that regional adaptations could yield measurable progress. This contrast point out a central contradiction: state-backed frameworks deliver coherence but may lack flexibility, whereas decentralized models foster innovation but struggle with long-term consistency.

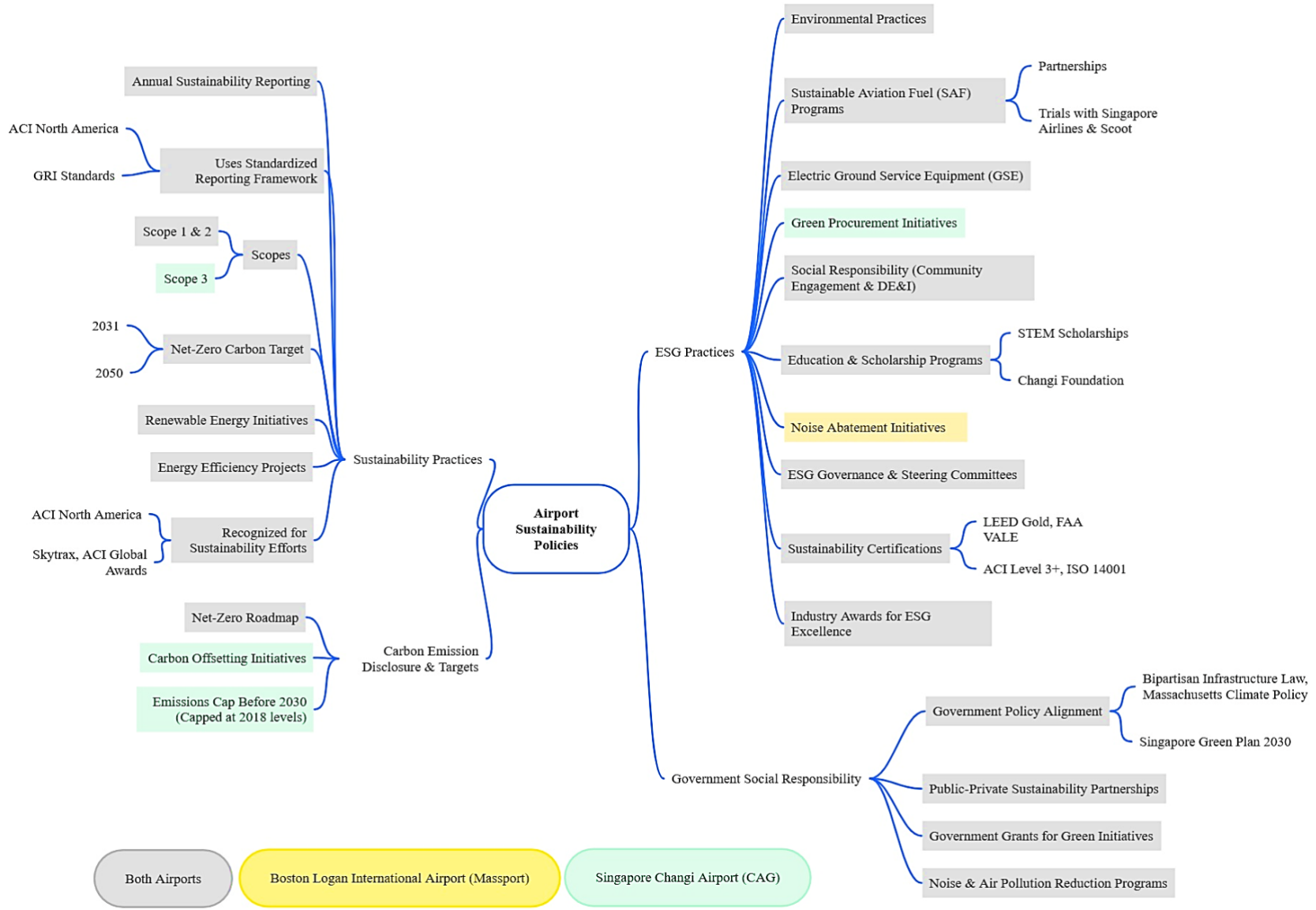

Figure 9: Mind Map of Airport Sustainability Policies

CHAPTER 6 - CONCLUSION

In search of an answer to the research question - How do airport sustainability policies compare in terms of their treatment of carbon emissions, ESG initiatives, and government social responsibility (GSR)? - this comparative analysis reveals fundamental divergences between Boston Logan International Airport and Singapore Changi Airport that reflect their distinct institutional ecosystems. While both airports demonstrate leadership in sustainable aviation, Boston Logan's market-driven, target-oriented approach contrasts sharply with Changi's state-coordinated, systems-based strategy, exposing critical trade-offs between policy implementation speed and sustainability reporting depth.

Boston Logan International Airport has made significant strides in addressing direct emissions (Scope 1 and 2) through initiatives such as its Net Zero Roadmap, which targets carbon neutrality by 2031. The airport’s focus on energy efficiency, renewable energy adoption, and sustainable infrastructure, evidenced by LEED Gold and Silver certifications, underscores its commitment to environmental stewardship. Additionally, its strong state-level support, including alignment with Massachusetts’ Next-Generation Roadmap for Climate Policy, provides a robust foundation for its sustainability efforts. However, the analysis identifies a key area for improvement: the limited reporting and mitigation of Scope 3 emissions, which encompass indirect emissions from aircraft operations, passenger activities, and supply chains. Addressing this gap would enhance Boston Logan’s transparency and align its practices with global sustainability standards, such as those exemplified by Changi Airport.

Singapore Changi Airport, in contrast, exemplifies a comprehensive and integrated approach to sustainability. Its alignment with Singapore’s Green Plan 2030 and the Carbon Pricing Act ensures coherence with national climate goals, while its ACI Level 3+ Carbon Accreditation and ISO 14001 certification reflect its leadership in carbon neutrality and environmental

management. Changi's aggressive tracking of Scope 3 emissions, coupled with innovative initiatives such as Sustainable Aviation Fuel (SAF) trials and green procurement practices, positions it as a global benchmark for airport sustainability. Furthermore, its long-term climate resilience strategies, including advanced flood protection systems and stakeholder collaboration, demonstrate a forward-looking approach to addressing climate risks. These efforts are bolstered by robust public-private partnerships and a well-structured governance framework, which enable Changi to integrate environmental, social, and governance (ESG) principles across its operations effectively.

The analysis also highlights the role of government support and policy frameworks in shaping airport sustainability strategies. While Boston Logan benefits from federal and state-level funding, such as the Bipartisan Infrastructure Law (BIL) and FAA VALE grants, its approach remains fragmented compared to Changi's integration with Singapore's national sustainability agenda. Changi's success in leveraging government support, public-private partnerships, and sector-wide collaboration provides a model for how airports can achieve systemic sustainability outcomes. This contrast underscores the importance of cohesive governance and policy alignment in driving long-term environmental and social impact.

In terms of industry recognition, both airports have earned awards for their sustainability efforts, though the scope and scale of their achievements differ. Boston Logan's regional awards for noise abatement, community engagement, and sustainable building design reflect their strong local impact. However, its limited global visibility in sustainability rankings presents an opportunity for improvement. Changi, on the other hand, has consistently been recognized as a global leader, with multiple sustainability awards, IATA CEIV Fresh certification, and top rankings in Skytrax's world airport evaluations. These achievements

highlight the importance of innovation, stakeholder engagement, and comprehensive reporting in achieving global sustainability leadership.

This also shows the comparative analysis that underscores the strengths and areas for improvement in the sustainability strategies of Boston Logan International Airport and Singapore Changi Airport. Boston Logan's focus on direct emissions reductions and community equity is commendable, but adopting a more integrated approach to Scope 3 emissions and enhancing its governance framework would strengthen its sustainability profile. Changi's holistic approach, characterized by emissions tracking, long-term resilience planning, and innovative practices, sets a high standard for the industry.

By learning from each other's strengths; Boston Logan's operational efficiency and local engagement, and Changi's global innovation and comprehensive governance; both airports can further enhance their contributions to environmental stewardship, social equity, and ethical governance. This thesis offers a valuable lesson for airports worldwide, emphasizing the need for balanced, collaborative, and ambitious approaches to sustainability in the aviation sector.

Limitations of the Research

In conducting this comparative analysis of sustainability policies at Boston Logan and Singapore Changi airports observed several limitations that constrained the scope and depth of my investigation. My reliance on publicly available reports meant that my analysis was potentially incomplete, as confidential data or internal policies were not accessible, and the temporal scope was limited by publication dates, possibly excluding recent initiatives. Additionally, differing reporting cycles and cultural and regulatory disparities between the U.S. and Singapore complicated direct comparisons, as sustainability priorities and metrics varied significantly. The absence of standardized measurements for social impact further hindered my evaluation of community engagement efforts, while the focus on only two airports restricted

the generalizability of my findings. Moreover, I was unable to fully assess the implementation or effectiveness of reported initiatives due to potential gaps in data and the lack of independent verification. To address these limitations, I employed a critical approach, cross-referencing multiple reports, journal articles, and news, and triangulating data where possible, while remaining mindful of potential biases inherent in promotional materials and striving for a balanced interpretation of the findings.

Recommendations for Future Research

This study's comparative framework and findings offer a foundation for broader investigations into airport sustainability policies. Future research should explore the scalability of the best identified practices, such as Changi's integrated emissions reporting and Boston Logan's rapid decarbonization strategies, across diverse airport contexts, including regional hubs and emerging-market facilities. While this analysis focused on two distinct cases, the resulting insights provide a universal template for developing robust sustainability policies, regardless of an airport's size, location, or governance structure. Specifically, researchers could examine: (1) the role of regulatory harmonization in bridging gaps between regional and global reporting standards, (2) the financial and operational feasibility of voluntary adopting Scope 3 emissions tracking in resource-constrained settings, and (3) the impact of digital technologies (e.g., AI-driven energy management) on achieving net-zero targets.

Additionally, longitudinal studies assessing the long-term efficacy of sustainability interventions, such as Boston Logan's electrification initiatives or Changi's climate resilience measures, would strengthen evidence-based policymaking. Given that airports worldwide face similar challenges in balancing growth with environmental stewardship, this study's framework can serve as a benchmark for evaluating and refining sustainable aviation strategies across the industry. Future work should also incorporate stakeholder perspectives (e.g., airlines,

local communities) to ensure policies align with both operational realities and societal expectations that will ultimately advance a more standardized, actionable approach to airport sustainability.

Policy Recommendations

Based on my comparative analysis of Boston Logan International Airport and Singapore Changi Airport, I recommend that policymakers prioritize integrated emissions tracking to enhance transparency and align with global sustainability benchmarks. My findings suggest that adopting Changi's systems-based approach, such as its rigorous carbon accounting and Sustainable Aviation Fuel (SAF) trials, could strengthen Boston Logan's market-driven strategy, while Boston Logan's rapid decarbonization roadmap and community-focused initiatives offer a replicable model policy for operational efficiency. To bridge existing gaps, I propose harmonizing regional and international reporting standards, incentivizing public-private partnerships for scalable green infrastructure, and embedding long-term climate resilience into policy frameworks. These measures, coupled with voluntary Scope 3 disclosure and stakeholder engagement mechanisms, would advance equitable, governance-aligned sustainability outcomes across diverse airport ecosystems.

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APPENDIX 1: NOISE EXPOSURE FOR LOGAN AIRPORT

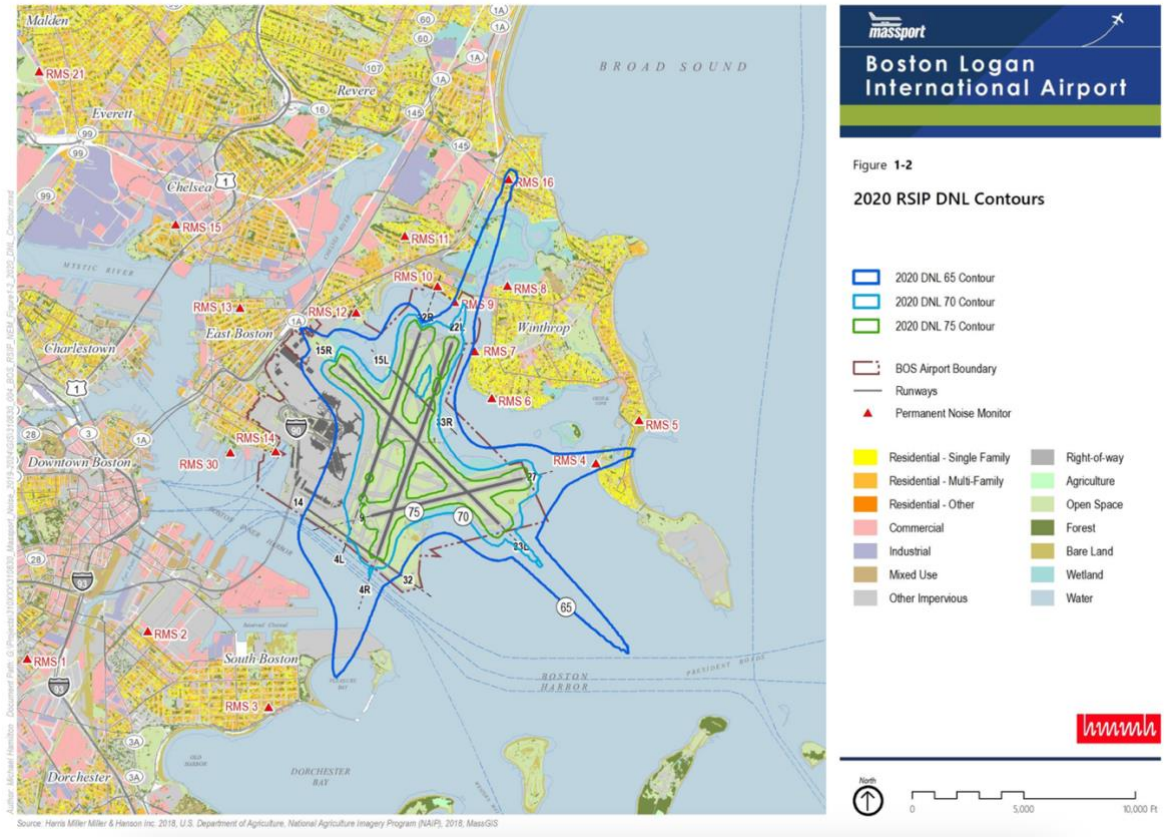

Figure 10: 2020 Noise Exposure Map for Boston Logan. Source: *(Larson and Mentzer 2021)*

This analysis presents the 2020 Day-Night Average Sound Level (DNL) noise contours generated using the Federal Aviation Administration's Aviation Environmental Design Tool (AEDT) version. The modeling focuses particularly on areas experiencing DNL levels of 65 dB or higher, which both the FAA and U.S. Department of Housing and Urban Development consider incompatible with residential use. The resulting contours, displayed in 5-decibel increments from 65 to 75 dB, have been mapped against local land use patterns. The analysis reveals that residential exposure to DNL 65 dB or higher is limited to specific neighborhoods in Winthrop (Point Shirley), Revere, and East Boston (Orient Heights). These affected residential areas have previously qualified for Massport's Residential Sound Insulation Program (RSIP), and Massport continues to conduct outreach to eligible property owners who have not yet participated in the noise mitigation program.