Understanding Airport Resilience & Adaptation: Insights from Airport Managers

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1. Impact of climate risk on Airports

The Intergovernmental Panel on Climate Change (IPCC) has urged governments to prioritize adaptation to mitigate severe climate change effects. 2023 and 2024 saw major extreme rainfall events which disrupted airport surface access, diverted or delayed flights and damaged critical infrastructure, impacting aerodrome operations. The weather patterns are predicted to intensify despite the global net-zero commitments. Latest reports from IPCC have determined that the earth's global average temperature will surpass the 1.5°C target set out in the Paris Agreement regardless any action taken to cut greenhouse gas emissions (GHG). Consequently, it is expected that climate change impacts will increase in frequency and severity around the globe, affecting not just temperatures but causing unpredictable weather events, sea level rise and threats to infrastructure, transport supply chains, communities and the economy.

Airports are critical infrastructures that facilitate the movement of people and goods, making them vital to the global economy. However, they are increasingly vulnerable to extreme weather events, geological hazards and climate change. According to a World Meteorological Organization (WMO) study, climate change is already influencing the weather hazards and extreme events that impact aviation operations[1] These challenges include rising sea levels, extreme temperatures, and extreme precipitation and winds including storms, floods, cyclones, and hurricanes. Such extreme events can cause significant damage to airport infrastructure, disrupt operations, and impact financial stability.

To address these challenges, airports need to adopt climate adaptation and resilience strategies. This involves integrating infrastructure resilience practices to mitigate climate risk considerations into the design, construction, and operation & maintenance of airport infrastructure. By doing so, airports can enhance their ability to withstand and recover from climate-related disasters, ensuring continuity of operations and safety for passengers and staff.

Coalition for Disaster Resilient Infrastructure is conducting a Global Study on Disaster Resilience of Airports (GSDRA) to present the state of the aviation industry's response to climate risk. The phase 1 of the study focused on the airport's perception of resilience and capturing the current state of the industry. The phase 1 report highlights the key impacts of climate risks on airports.

a) Infrastructure Damage

Extreme weather events can cause extensive damage to airport infrastructure, including runways, terminals, and support facilities. This damage can lead to costly repairs and prolonged downtime. The key reasons for this are noted to be:

1 https://library.wmo.int/viewer/69458/download?file=AeM_Series_9_en.pdf&type=pdf&navigator=1

i. Ageing Infrastructure and Assets: Many airports operate with ageing infrastructure that was not designed to withstand current and future climate risks. This makes them particularly vulnerable to damage from extreme weather events. The GSDRA phase 1 report highlights the case of Don Mueang Airport in Bangkok. Don Mueang airport is one of the oldest international airports in the world and the oldest operating airport in Asia. In 2011, it was severely impacted by floods which led to temporary shutdown of the airport's runway. The airport was used as a temporary base for the government's relief efforts, while its runways were closed for several weeks as floodwaters inundated the area. The airport was not operational for 4 months and nearly 1.4 billion baht (52 million USD) were spent to restore it. [2] The airport implemented flood mitigation measures like berms, flood walls and sheet. Additionally, a temporary modular flood barrier system was developed to provide rapid response.

FIGURE 1: Closure due to floods- Don Muang Airport (Bangkok). Source: Thailand floods: Bangkok Don Mueang Airport pictures show extent of crisis | Daily Mail Online[3].

ii. Design and Construction Without Consideration of Climate Risks: Historically, airport design and construction seldom accounted for climate risks, leading to infrastructure that is ill-prepared to manage the impacts of climate change. This lack of preparedness can result in significant damage and operational disruptions. An example is the case of Kansai International Airport in Japan, which was inundated by Typhoon Jebi's storm surge in 2018. The airport had to close one runway for 10 days and a terminal for 17 days, highlighting the need for climate-resilient designs.

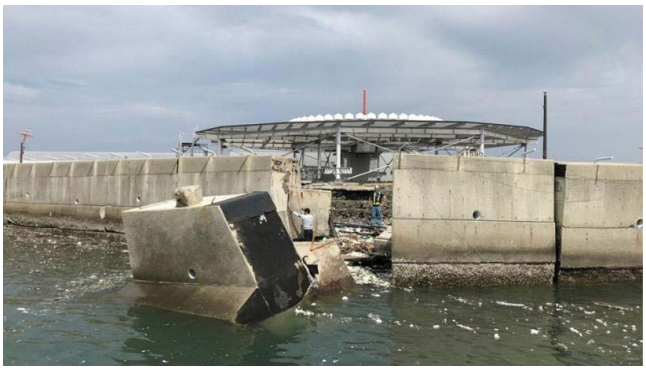

FIGURE 2: Typhoon Jebi's Impact on Kansai International Airport. Source: Improving climate resilience at Kansai International Airport[4].

b) Operational Disruptions

Operational disruptions can be caused by failure of critical infrastructure and/or unfit conditions for operations like low visibility or rain or snowstorms making the airfield unsafe for airside workers. This leads to flight delays, cancellations, and reduced capacity. These disruptions can have cascading effects on the broader transportation network and economy. Delays have a significant financial impact on airlines and airports and also significantly affects their brand image.

c) Impacts on Financial and Business Continuity

The financial impacts of climate-related disruptions can be severe, affecting revenue, increasing operational costs, and potentially leading to long-term financial instability. Additionally, post disaster recovery often comes with a heavy capex for infrastructure repair. Ensuring business continuity in the face of these challenges is critical for the sustainability of airport operations. For Kansai International Airport the estimated economic impact of Typhoon Jebi was around USD 500 million.

2 https://www.bbc.com/news/world-asia-17267833
3 https://www.dailymail.co.uk/news/article-2055644/Thailand-floods-Bangkok-Don-Mueang-Airport-pictures-extent-crisis.html
4 https://www.naco.nl/en/projects/improving-climate-resilience-at-kansai-international-airport

3. Understanding Airport Managers' Perspectives

Airport managers are increasingly aware of the risks posed by climate change. The CDRI GSDRA Phase 1 study, having participation from 111 airports from 54 countries, aimed to understand the state of the industry through the following:

FIGURE 3: Structure of the GSDRA Phase 1 Study.

The study revealed the regional differences in approaches and maturity towards climate resilience across regions, airport sizes and ownership. For instance, airports in high income countries were seen to have conducted frequent risk and vulnerability assessments. This was driven by the access to good data, more resources, and regulatory / management motivation for action. It was also seen that larger airports (30-50 Million Annual Passengers - MAP) had the resources to purchase subscription-based datasets to inform their studies.

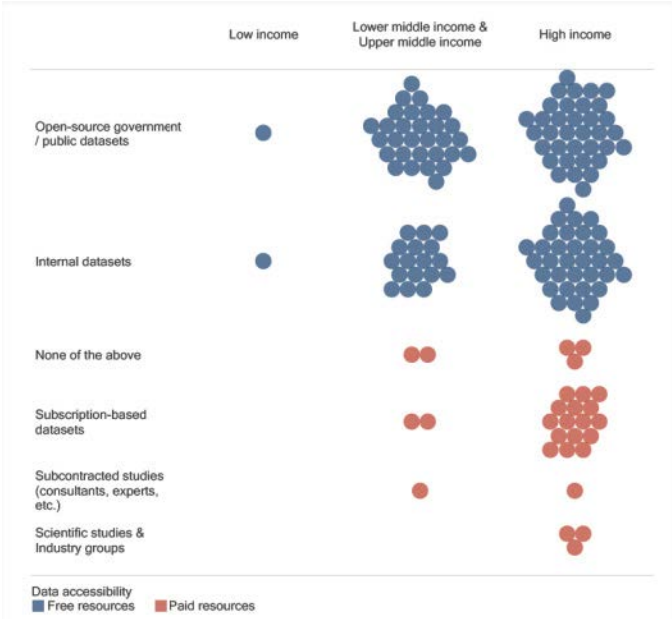

FIGURE 4: Access to data across different economies. Source: GSDRA Phase 1 Report.

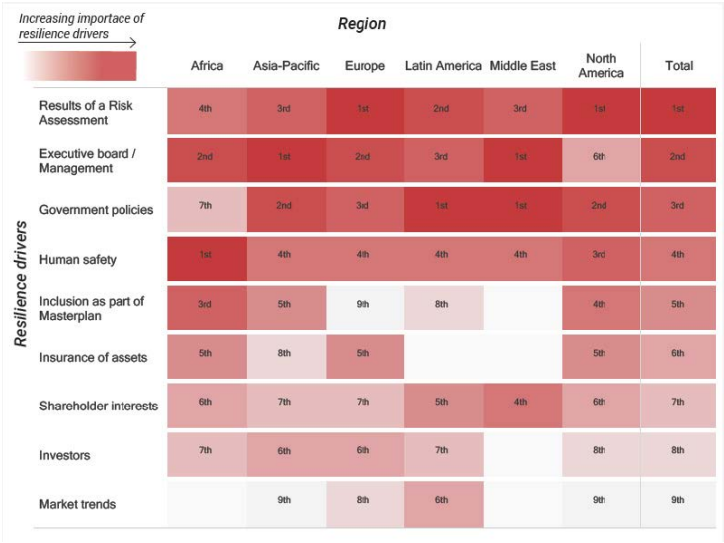

FIGURE 5: Climate risk drivers across regions. Source: GSDRA Phase 1 Report.

a) Understanding of Existing Regulations and Policies on Airport Resilience

There is a growing awareness of the importance of regulatory frameworks and policies that support airport resilience. However, the study highlighted that there are gaps in the implementation and enforcement of these regulations, which can hinder resilience efforts. Airports need to work closely with regulatory bodies to ensure that resilience measures are effectively integrated into their operations

b) Organisational challenges in integrating adaptation efforts

Integrating climate adaptation and resilience into an airport organisation and operations presents several challenges. These include limited financial resources, lack of technical expertise and training, and improper communication or coordination with the stakeholders' ecosystem. The study results highlight that airports with sufficient in-house capacity were more effective in mitigating risks. There is a need for in-house capacity building as well as streamlined stakeholder engagements for successful adaptation planning.

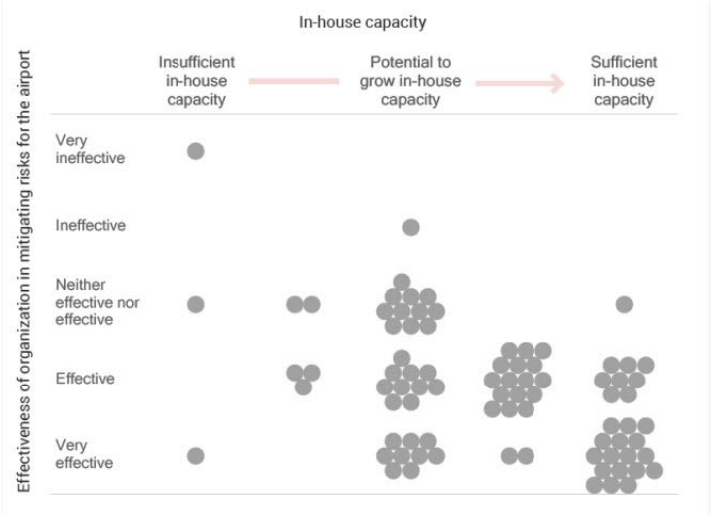

FIGURE 6: Organisations effectiveness vs in-house capacity.

c) Priorities of Airports in the Decision-Making Process

Airport managers prioritize safety, operational efficiency, and financial stability in their decision-making processes. Balancing these priorities with the need for climate resilience requires careful planning and investment. The CDRI Phase 1 study found that airports are increasingly considering resilience as a key factor in their decision-making.

d) Factors Influencing Recovery and Resumption of Operations

The ability of airports to recover and resume operations after a disaster is influenced by several factors, including the availability of emergency response plans, the resilience of critical infrastructure, and the effectiveness of coordination with external agencies. Availability of resources and effective regulatory frameworks for disaster response are also key contributors for early recovery. The CDRI Phase 1 report highlights the importance of having robust recovery plans and the need for regular drills and exercises to ensure preparedness.

FIGURE 7: Comparison of time taken to resume from flooding.

4. Key Takeaways from GSDRA Phase 1 and Regional Insights

a) Findings from Global Airport Resilience Assessments

The GSDRA Phase 1 study provided valuable insights into the current state of airport resilience globally. Key findings include the need for improved risk assessment practices, the importance of stakeholder collaboration, and the benefits of investing in resilient infrastructure. This validates the ICAO Environmental Report 2022 emphasis on the importance of integrating climate resilience into airport planning and operations.

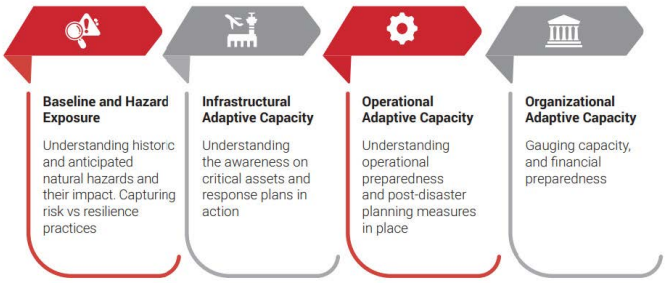

FIGURE 8: Key take-ways from CDRI Phase 1 study.

b) Regional Variations in Risk Perception and Response

The study highlighted significant regional variations in how airports perceive and respond to climate risks. Both the ICAO Environmental Report 2022 and the ACI LAC Survey which focused on understanding the challenges in the Latin American region, also discussed regional differences in climate risk perception and response, noting that airports in Asia-Pacific and Africa face unique challenges due to their geographical and socio-economic contexts

c) What Are 5 Things That Airports Can Do

FIGURE 9: Five Steps towards resilience of airports.

5. Innovative Strategies for Enhancing Airport Resilience

a) Use of Advanced Technologies

Airports are increasingly leveraging advanced technologies to enhance resilience. For example, the use of real-time data analytics and predictive modelling helps in anticipating and mitigating the impacts of extreme weather events. Technologies such as Geographic Information Systems (GIS) and remote sensing are used to monitor and manage climate risks effectively. However, access to reliable datasets remains a challenge which should be addressed by the entire aviation ecosystem collectively, specially through governing bodies.

b) Development of Climate-Resilient Designs

Innovative design approaches are being adopted to make airport infrastructure more resilient to climate change. This includes the use of materials that can withstand extreme temperatures and the construction of elevated runways and terminals to protect against sea-level rise and flooding.

c) Implementation of Green Infrastructure and nature-based design

Green infrastructure solutions, such as green roofs, permeable pavements, and rain gardens, are being implemented for improved management of stormwater and to regulate the urban heat island effect. Nature-based design is also increasingly being adopted as a core concept where the natural elements on the site are preserved and enhanced. This allows for natural drainage of the land and in turn protects the infrastructure which is not designed at vulnerable locations. These solutions not only enhance resilience but also contribute to environmental sustainability.

d) Adoption of Renewable Energy Sources

Airports are increasingly adopting renewable energy sources, such as solar and wind power, to reduce their carbon footprint and enhance energy resilience. This not only helps in mitigating climate change but also ensures a reliable energy supply during extreme weather events. Redundancy in the power system reduces dependence

on the central grids and ensures business continuity in times of power outage.

e) Collaboration and Knowledge Sharing

Collaboration and knowledge sharing among airports, governments, and industry stakeholders are crucial for enhancing resilience. Initiatives such as the Global Airport Resilience Network (GARN) facilitate the exchange of best practices and innovative solutions for climate adaptation.

6. Ongoing Work of CDRI on Global Airport Resilience

CDRI Is committed to advocating for infrastructure resilience through its airport infrastructure resilience program.

a) GSDRA Phase-2

The Phase 2 builds on the findings of Phase 1 by conducting detailed assessments of 13 selected airports across 12 countries, each with varying risks and geographies. This phase will focus on exploring disaster risk management practices and financing mechanisms, with a focus on actionable recommendations and credit rating systems to ensure sustainable business continuity.

b) Technical Guidance Notes on Preparedness Measures for Airports with use cases and examples

CDRI is developing technical guidance notes to help airports implement effective preparedness measures. These notes aim to provide asset-level advisory, providing tailored, actionable guidance for specific hazards such as pluvial, fluvial, and tidal flooding. It offers targeted recommendations on structural and non-structural, engineered and operational measures that are easily integrable into Business Continuity Plans to help airport operators enhance resilience and make informed investment decisions across the disaster phases. Complementing the above measures, the team is also working to link them with real-world examples and practical solutions, facilitating implementation and encouraging cross-learning among airport operators and other critical infrastructure sectors

The notes will be validated with industry bodies like ACI through their environmental working group.

c) Simplified Guidance Notes on Risk Assessment and Procurement Frameworks for Airports

To implement the above recommendation and help airport operators with guidance on risk assessment & procurement, simplified guidance notes are being developed to assist airports in conducting risk assessments and developing procurement frameworks that prioritize infrastructure resilience and developing redundancy and business continuity.

CDRI would like to thank all the airports who participated in the GSDRA study, ACI World and the regional chapters and ICAO for their invaluable support for its airport resilience efforts.