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Benchmarking airports based on a sustainability ranking index

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ABSTRACT

This paper develops and applies a Sustainability Ranking of Airports Index to benchmark the performance of airports across multiple factors. The index is a composite indicator with 5 dimensions and 25 indicators. The dimensions are airport services and quality, energy consumption and generation, carbon dioxide emissions and mitigation planning, environmental management and biodiversity, and atmosphere and low emission transport. The index is applied to a sample of 9 airports that take place among the busiest and best airports in the world based on passenger traffic and passenger satisfaction. Data is mined from Corporate Sustainability Reports and related sources. Amsterdam Schiphol, Frankfurt, Munich, Istanbul Atatürk, and London Heathrow airports are the top 5 airports in the sample. The linear regression between the results of the index and annual passenger traffic is found to be 0.1942. The results can be used to benchmark progress in decoupling airport operations from greater environmental impact. The paper provides recommendations for the 5 dimensions of the index based on best practices from the airports in the sample. The index is useful to allow airport managers to coordinate strategies for the sustainable development of energy, water, and environment systems in airports and lift-off towards more sustainable airport practices.

1. Introduction

Airports act as an interface between landside access to ground transport and airside access to the airspace (Ashford and Wright, 1992). A multitude of priorities must be satisfied as efficiently as possible in the complex of terminals, gates, the apron, and the system of runways and taxiways for the timely and secure movement of passengers and aircraft. Adler et al. (2013) benchmarked 43 European airports based on cost and revenue. Other studies benchmarked airports based on management strategies (Ülkü, 2015) and ground handling activities (Schmidberger et al., 2009). Beyond key operations, airports are adopting measures to increase environmental stewardship. Airports are seeking to decouple economic growth from environmental pressure – a key aspect of sustainable development (Cropper, 2008). Fig. 1 classifies the studies that have addressed various aspects of sustainable airports.

1.1. Environmental impact of individual airports

In Fig. 1, studies that focused on the environmental impact of individual airports are given in the first cluster. Santoli et al. (2015) analyzed a combined heat and power (CHP) based energy system proposal for Bari Airport. Silvester et al. (2013) explored scenarios for integrating electric vehicles in Amsterdam Schiphol Airport. Postorino and Mantecchini (2014) developed and applied a carbon footprint method for the land vehicles, on-ground aircraft, airport handling, and terminal equipment at Bologna Airport. Kılkış (2014) analyzed a third airport proposal for Istanbul including the CO_2 emissions impact from a deforested area. Couto et al. (2015) analyzed a greywater treatment unit in a Brazilian airport. Neto et al. (2012) proposed potable water savings of at least 66% based on the use of rainwater tanks at Tancredo Neves International Airport in Brazil. Zietsman and Vanderschuren (2014) assessed a multi-airport development plan in Cape Town in South Africa.

1.2. Specific environmental aspects for multiple airports

Other studies focused on specific aspects of the environmental impact of multiple airports. These studies are given in the second

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Nomenclature

A	international airport in the sample
D	dimensions of the SRA Index (D_1–D_5)
D_1	Airport services and quality dimension
D_2	Energy consumption and generation dimension
D_3	CO_2 emissions and mitigation planning dimension
D_4	Environmental management and biodiversity dimension
D_5	Atmosphere and low emission transport dimension
E	energy consumption of the airport in Equation (A.3), toe
I	min–maxed values of the indicators of the SRA Index ($I_{1.1}$–$I_{5.5}$)
i	data inputs to the indicators prior to the min–max method
L_{eq}	equivalent long term noise level, dB(A)
L_{dn}	day–night average sound level, dB(A)
max	maximum value among all airports for a given indicator
min	minimum value among all airports for a given indicator
PM_{10}	Particulate matter up to 10 μm in diameter, μg/m^3
S	sample for the SRA Index application
s	share of electricity used for airport cooling

Greek symbols

α	weights of the dimensions of the SRA Index

Chemical symbols

$CHKO_2$	Potassium formate
CO_2	Carbon dioxide
NO_x	Nitric oxide (NO) and nitrogen dioxide (NO_2)
SO_x	Sulfur oxides, e.g. sulfur dioxide (SO_2) and sulfur trioxide (SO_3)

Subscripts

F	fuel usage in airport in Equation (A.3)
L	electrical energy usage in airport
T	thermal energy usage in airport
v	average value, as in HDD and CDD in Equations (A.1) and (A.2)
x	indicator number in a dimension in Equations (1)–(3), dimensionless
y	dimension number in Equations (1)–(3), dimensionless
z	airport number in the sample in Equations (1)–(3), dimensionless

Acronyms

ACI	Airports Council International
ASQ	Airport Service Quality
AMS	Amsterdam Schiphol Airport
BCN	Barcelona El Prat Airport
CDA	Continuous descent approach
CDD	Cooling degree day
CHP	Combined heat and power
CSR	Corporate Sustainability Report
FRA	Frankfurt Airport
GPU	Ground power units
GRI	Global Reporting Initiative
HDD	Heating degree day
ICN	Seoul Incheon International Airport
IST	Atatürk International Airport
LEED	Leadership in Energy and Environmental Design
LGW	London Gatwick Airport
LHR	London Heathrow Airport
MUC	Munich Airport
NPD	Noise-power-distance
PAX	Annual passenger traffic
SFO	San Francisco International Airport
SRA	Sustainability Ranking of Airports

cluster in Fig. 1. For example, Balaras et al. (2003) estimated up to a 35% energy savings potential in 29 airport buildings in Greece. Wybo (2013) assessed the influence of large-scale photovoltaic (PV) panels on airport safety. Stettler et al. (2011) modeled the CO_2 emissions of the landing and takeoff (LTO) cycle at UK airports. Monsalud et al. (2014) examined CO_2 mitigation strategies at U.S. airports. Carvalho et al. (2013) reviewed practices in Brazilian airports to conserve water. Pitt and Smith (2003) compared waste management at UK airports. Giustozzi et al. (2012) analyzed the use of recycled materials in Italian airport pavements. Upham (2001) compared rising trends in passenger numbers and waste at four European airports.

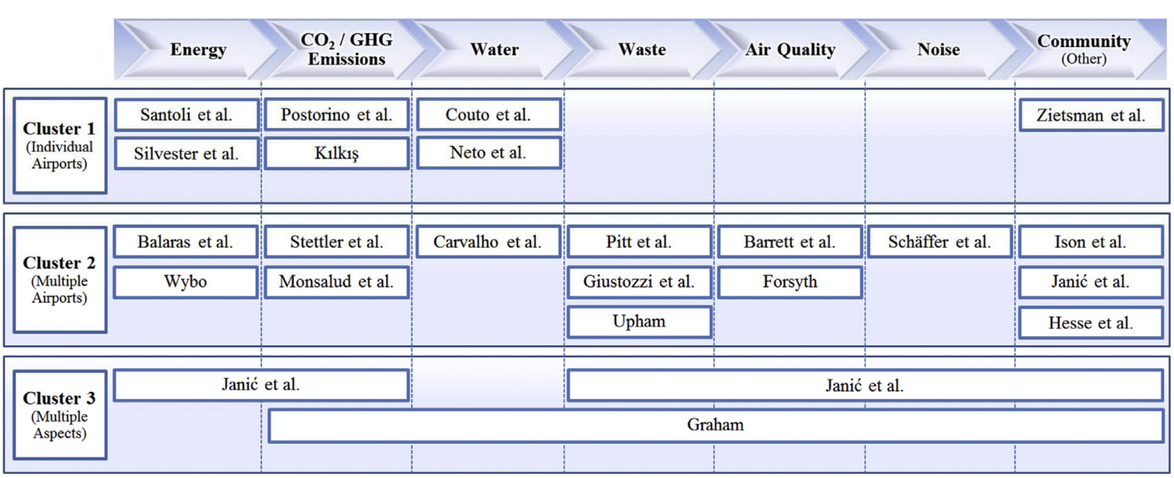

Fig. 1. Clusters in the sustainable airports literature.