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Greenhouse gas emissions mitigation strategies within the airport sustainability evaluation process

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ABSTRACT

In recent years the aviation industry has initiated new sustainability efforts as a response to society's greater needs for living in healthier and more sustainable environments. Significant attention has been directed toward aircraft and their contribution to greenhouse gas emission. As we look at the aviation system more holistically, especially in the U.S., however, we discover a lack of comprehensive research addressing sustainability evaluation standards in airports. Sustainability, in a system as complex as an airport, can encompass many different areas such as water conservation, design and construction techniques, and emissions reduction. Because sustainability can encompass so many different aspects in the design, master planning, operations, and maintenance of an airport, airport managers can experience difficulty in analyzing how to plan for sustainability most effectively. As a response, this paper develops an evaluation process with the use of an influence matrix through which to determine effective sustainable practices at U.S. airports. This evaluation method attempts to quantify and thus improve decision-making in airport sustainability. By using a case study, we also look at airport emissions mitigation strategies that can be developed into a framework.

1. Introduction

1.1. Sustainability and airports

Until recently airports have mainly measured their success by metrics such as financial performance, number of annual operations, or the total number of enplaned passengers. As developed societies around the world are starting to emphasize healthier and more sustainable environments, however, the aviation industry is initiating its own sustainability efforts. In light of aviation sustainability efforts, U.S. airports are gradually introducing new ways of measuring their success by balancing aspects of environmental stewardship, economic growth, and social responsibility (LAWA, 2008).

Airports play a large role in today's globalized society; they are critical nodes in the global network and as such, sustainable practices relevant to the operation and maintenance of airports will continue to have a growing impact on the global environment and on people. Air transportation is responsible for numerous negative impacts such as air and noise pollution. As has been observed over time, the aviation industry has been steadily growing (FAA, 2011), and as expected, the negative impacts have grown as well, as evidenced by increasing emissions. With the growing industry and its associated negative impacts, prioritizing the quality of life for those using and living near airports is becoming increasingly important.

Airports are currently designed with efficiency and economic growth as priorities (Boons, Van Buuren, & Teisman, 2010). Also, while the U.S. Federal Aviation Administration (FAA) and local communities may enforce certain sustainability regulations for airports, these regulations are quite limited. Until recently, it was up to the airports to enact the most important sustainability practices and deeply incorporate sustainable designs into the planning process (SAGA, 2013).

In the U.S., airport sustainability planning can be achieved through different avenues such as facility design and construction guidelines (LAWA, 2008), sustainability management systems (ATL, 2011), stand-alone sustainability plans (SFO, 2011), sustainability reporting (Massport, 2011) and sustainable master plans (ITH, 2012). Only through sustainable master plans can long-term

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sustainability be fully integrated into the airport planning process (ITH, 2012). Since 2010, the FAA has supported sustainable master planning efforts through two pilot programs (FAA, 2012) and has provided federal funds to 25 airports across the U.S. The purpose of the pilot programs is to assist airports in incorporating sustainability into airport long-range planning and to create sustainable master plans. Because this entire initiative is new, the guidelines and frameworks for evaluating airport sustainability within pilot programs for sustainable master plans are in their initial stages, too. Hence, our study contributes to the FAA's current pilot program efforts by creating guidelines and frameworks for airport sustainability evaluation and by providing mitigation strategies to reduce negative environmental impacts.

In a structured and systematic way, our study identifies the steps airports can take to analyze, and reassess their approach to traditional master planning and environmental concerns. Because sustainable master planning takes environmental concerns beyond traditional environmental impact analyses, the proposed airport sustainability evaluation process should be able to evaluate a much wider range of impacts, including social, economic and physical.

In general, environmental impact identification techniques vary with a scope of environmental impact assessments (EIAs) that can be used to examine environmental consequences of a planned project. Environmental impact identification techniques can be classified into checklists, matrices, quantitative methods, networks and overlay maps (Glasson, Therivel, & Chadwick, 2012). Matrices, defined as simple two-dimensional tables, have been used successfully in many EIAs to examine the impacts of a project's components (such as construction, buildings, and operations) on the environment (Glasson et al., 2012; Leopold, Clarke, Hanshow, & Balsley, 2012).

This study extends previous studies that use two-dimensional matrices in the traditional EIA domain, and develops a multilayered comprehensive influence matrix for environmental sustainability evaluation. The study is also based on a theoretical approach to the environmental sustainability evaluation of airport development alternatives, previously developed by Fann and Rakas (2011, 2013). The proposed multilayered influence matrix consists of user-defined airport functional areas (such as airport terminal facilities, airfield lighting and service vehicles), and suggests examining their impact on various impact categories (such as greenhouse gas emissions, land disturbances, wildlife and people). This influence matrix enables an airport planner to determine the most relevant airport performance indicators while searching for critical sustainability issues at a specific airport. In the following step, a developed methodology is used to quantify performance indicators. Finally, a case study is provided as means to quantify and mitigate a specific performance indicator, greenhouse gas emissions. This methodical approach for evaluating airport sustainability and applying mitigation strategies is very generic, and, therefore, can be used by any airport aiming to aid decision-making during various stages in sustainable master planning processes.

1.2. Airports and sustainability planning challenges

Airports deter from adopting sustainable planning because of a lack of information, guidelines, funding, and an overall lack of enforcement/regulation. Nevertheless, social demand is pushing airports to become more sustainable. This study aims to provide guidelines that airports may take to aggregate their own information for evaluation.

While the FAA provides environmental documents such as the Environmental Impact Statements (EIS), these documents focus more on planning efficiently rather than on planning sustainably.

In addition, current sustainable master plan pilot programs funded by the FAA provide general guidelines, leaving airports to develop their own evaluation methods. Furthermore, because a broad spectrum of sustainable practices (i.e., facility design and construction guidelines, sustainability management systems, stand-alone sustainability plans, and sustainability reporting) has been found at U.S. airports, no official sustainability evaluation methods and performance metrics are available to sustainability planners that could further assist and promote such a variety of sustainable practices.

Developing structured guidelines for sustainability evaluation is a necessary step toward efficient sustainable planning because sustainability can encompass so many different things in design, master planning, operations, and maintenance of an airport. Airport planners should be able to gather and analyze existing facility data easily within a structured multi-layered evaluation method to determine the optimal path toward sustainability. The reason this process needs to be facilitated is that currently no large incentive exists to overcome the problems deterring sustainable measures. To be effective, considering sustainability throughout the entire planning process is important. The measure of sustainability will differ from airport to airport because of the unique nature of each facility within its community. Sustainability should not be simple check marks of proposed plans; it should be a core objective that is woven throughout planning processes. The ACI-NA (2013) defines sustainability as "a holistic approach to managing an airport so as to ensure the integrity of the economic viability, operational efficiency, natural resource conservation and social responsibility (EONS) of the airport." The first step in achieving this grand goal of overall sustainability is to first develop a means of facilitating the evaluation process. A standard means of evaluation allows the process not only to be tailored to each airport but also to be effectively used in various stages of the planning process, whether in determining sustainable goals, making assessments, or evaluating alternatives and their following initiatives.

A discussion of such an evaluation process that aids decision-making during various stages in sustainable master planning processes follows.

2. Evaluation process: the influence matrix

To assist airport managers to make favorable choices regarding sustainability, we propose the use of an influence matrix to quantify any decision-making. The influence matrix constructed in Table 1 is an example of one that can be used for airports. The functional areas, which are the areas of the airport under examination, are crossed with impact categories, which are the various categories of the environment and sustainability that are impacted by the functional area of the airport. Functional areas are further divided into isolated consumptions and daily consumptions; impact categories are divided into global concerns and local concerns. Both the functional areas and impact categories can be user-defined and airport-specific.

Isolated consumption includes general planning, and construction and maintenance of the airfield and terminal. General planning includes the design, layout, and material choices of the terminal and runways. For example, runway design traditionally takes into account wind direction as well as aircraft type, which dictate the direction and length of the runway. Taking sustainable approaches into account, however, the designer should also consider pervious runway pavements, or land disturbance and encroachment onto wildlife territory. Airfield and terminal construction, and maintenance also fall under isolated consumption and can affect the impact categories through decisions such as choosing to install carpet vs. stone flooring (ACRP, 2012).

The daily consumption category includes the airfield, terminal, and vehicle functional areas – and looks at how these areas have more frequent effects, such as lighting, in either the airfield or

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