EMERGING TRENDS IN SUSTAINABILITY PRACTICES AT AIRPORTS: AN ANALYSIS OF AWARENESS AND OPERATIONAL CHANGES AT COMMERCIAL SERVICE AIRPORTS IN NORTHERN OHIO

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EMERGING TRENDS IN SUSTAINABILITY PRACTICES AT AIRPORTS: AN ANALYSIS OF AWARENESS AND OPERATIONAL CHANGES AT COMMERCIAL SERVICE AIRPORTS IN NORTHERN OHIO (65PP.)

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This thesis involves an empirical case study carried out at four commercial service airports in Northern Ohio to explore emerging trends in sustainability practices. Although the growth of aviation related activities brings about significant expansion of aviation infrastructure, which consequently create extensive benefits that include employment, business, trade, tourism and community prosperity and pride, unfortunately there are associated adverse side effects. Some airport operations have been linked to waste products and water, noise and land pollution. These have prompted health and environmental concerns, thus bringing the idea of airport sustainability to the forefront. This empirical case study employed a survey questionnaire to explore how four commercial service airports in Northern Ohio responded to five areas addressing sustainability. Data analysis revealed that, policies and practices followed by these airports are largely driven by local, state and regional environmental regulations. The scale of the airport operations seem to be the determining factor on the extent and focus of the sustainability area, thus airports with more operations are under more strict rules
and face extra sustainability challenges. Great responsibility rests on management to
develop the appropriate strategies, maintain and safely operate the airport asset by
aligning sustainability initiatives with the airport’s goals for better operational efficiency
and improved customer relations. These findings are significant since the future
development of commercial service airports, rests squarely on the success of
sustainability initiatives and their effect on the natural environments, the economic and
social well-being of local communities.
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CHAPTER 1

Introduction

This thesis seeks to study emerging trends in sustainability practices by focusing on the awareness and operational changes that have been undertaken at commercial service airports in Northern Ohio. There are four commercial service airports in Northern Ohio, namely: Cleveland Hopkins International Airport (CLE), Akron-Canton Regional Airport (CAK), Youngstown/Warren Regional Airport (YNG) and Toledo Express Airport (TOL). This study will review existing efforts at these four commercial service airports and the implementation of policies and programs that have been applied towards creating a sustainable environment. It is the aim of this thesis to determine and describe sustainability practices and challenges faced by these four commercial service airports in Northern Ohio.

The review begins by describing the problem briefly and stating the research question. An analysis of what the term sustainability entails is then provided as a basis and motivation for this research effort. A literature review of scholarly articles follows to discover what sustainability practices have been undertaken at selected large airports in the United States (U.S.). This section also discusses issues facing airports and gives a brief background of prior policies, and their goals and objectives.

The research methodology explores how four sampled airports in Northern Ohio responded to five areas addressing sustainability. As established, the policies and

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1 These four airports had a scheduled air carrier service at the time the thesis project was concluded.
practices followed by these commercial service airports are largely driven by local, state and regional environmental requirements as well as the scale of operations. Even so airports have a responsibility to undertake sustainability initiatives that stimulate the development of better operational practices and increased operational efficiencies, as well as improve on their environmental performance.

**Problem Statement**

Aviation-related activities at airports have grown exponentially over the past few decades, thus demonstrating a strong growth rate as compared to other modes of travel. In the recent past, mobility provided by the U.S. air transportation system has increased six-fold (Waitz, Townsend, Cutcher-Gershenfeld, Greitzer & Kerrebrock, 2004), mainly because airports provide access to networks that transport people and goods (Nettey, 2007) almost anywhere in the world. As such, they contribute to the prosperity of the local communities they serve and create opportunities for employment, business, commerce, trade and tourism, as well as development and cross cultural understanding (Sustainability Reporting Guidelines, 2011). This increase in demand has necessitated a significant expansion in aviation infrastructure, making both the direct and indirect impacts considerable.

Without a doubt, billions of people benefit from aviation, but countless others are adversely affected by the operational side effects of aviation. These side effects include waste products and water, noise, and land pollution, which cause health and safety concerns to those who work at airports and live in the surrounding community. There has
also been growing concern about the adverse impacts on the environment through carbon emissions. With demand for air transport continually growing and with it the pressure on airports to expand operations in order to accommodate and facilitate commercial travel, these negative impacts are becoming quite significant. Due to the challenges involved with aviation activities at airports, the issue of sustainability has increased in importance thus influencing regional thinking and policy making at the four commercial service airports in Northern Ohio. Thus the research question:

**Research Question**

How aware are the commercial service airports in Northern Ohio of the sustainability challenges they face, and what are the operational changes adopted to alleviate these challenges? This thesis hopes to answer this important question. First, what sustainability entails, and its implication in aviation is analyzed as a basis and subject for this research effort.

**Analysis of What Sustainability Entails**

Sustainability means different things to different people depending on political and scientific viewpoints (Kidd, 1992). The widely adopted definition is the Brundtland Report by the World Commission on Environment and Development, which defines it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 1987, ¶ 1). Sustainability therefore realizes the interconnectedness of human beings and the environmental systems in the three most important areas to their survival, namely: the economic, environmental
and social levels. These make up the three dimensions or pillars of sustainability which have been presented in several ways. This thesis will review two sustainability models, the Venn Diagram (weak sustainability) model and the Concentric Circles (strong sustainability) model.

Figure 1. Venn Diagram (Weak Sustainability) Model

Venn diagrams are believed to have been used for centuries by logicians and were made popular by John Venn, whose paper *On the Diagrammatic and Mechanical Representation of Propositions and Reasoning* presented in 1880 secured his position as their namesake (Venn, 2008). The diagrams comprise overlapping circles, which assist in visualizing the relationships between different objects or ideas. In the areas where they overlap, similarities between the two concepts are shown. Thus the sustainability concept
has borrowed from this perception to acknowledge the intersection of economic, environmental and social factors. Sustainability is understood to be found at the confluence of these three constituent circles.

A major shortcoming of the diagram is that the circles, depending on what is essential to a particular enterprise, can be re-sized to show one factor being more dominant than others. Usually the main priority in this model is the economy, therefore “economists sometimes refer to this as the weak sustainability model”, because “it assumes that the degradation of one group of assets, (environmental, social or economic) can be compensated for by improvement in another” (Parliamentary Commissioner for the Environment, 2002, p.34)

Figure 2: Concentric Circles (Strong Sustainability) Model

The Concentric Circles model looks at sustainability within the context that the economy exists within society, and that both the economy and society exist within the environment. As a result these have been referred to as “the three-nested-dependencies”
model because they reflect the co-dependent reality of sustainability. The Concentric Circles are said to represent strong sustainability because the model, recognizes that the economy is a subset of society (i.e. it only exists in the context of a society), and that many important aspects of society do not involve economic activity. Similarly, human society and the economic activity within it are totally constrained by the natural systems of our planet. (Parliamentary Commissioner for the Environment, 2002, p.7).

This clearly agrees with the whole idea of sustainability in that human activities are significant in deciding the state of the natural systems, which in turn will determine the continuation of human activities.

A major discrepancy between the two models is that the Venn diagram portrays the three areas of sustainability as competing interests, while ignoring some essential facts. It does not acknowledge the environmental constraints that humans, markets, policies and developments must operate within. The Venn diagram model is only concerned with the total picture rather than with the components that make it and it appears to maintain that the three areas can be substituted for each other. It assumes that environmental health could decline provided that human health increases by the same proportion. The Concentric Circles model in turn requires upholding the areas (society, the economy and the environment) in good condition as well as the whole. One area cannot be substituted for another, and in some situations there is only limited substitutability.
Sustainability efforts at the commercial service airports in Northern Ohio should acknowledge the intertwined co-dependent nature of the whole system, and realize that ignoring one aspect has alarming implications and resulting constraints on the other two. Incidentally, activities at these airports to sustain the economic wellbeing of society could result in the degradation and quality of the natural environment. In turn, the environmental impacts may play a part in the constraint on air transportation growth in Northern Ohio, affecting both the economy and society.

Efforts to address these challenges have resulted in environmental policies enacted locally as well as nationwide in order to balance the three sustainability areas to secure the wellbeing of present and future generations. As illustrated by the Concentric Circles model, none of these three areas can be substituted for each other. Consequently sustainability efforts have to address each area individually in order to attain a well-balanced and whole system. Therefore it is important that the sustainability decisions and practices at the commercial service airports in Northern Ohio reflect an understanding of these three interests and the interactions and tensions that occur among them.

**Economic sustainability.** Economic sustainability calls for strategies that efficiently utilize available resources to best advantage. True economic sustainability encourages responsible use of resources and ensures profitability for the business enterprise while being mindful of the ecological footprint on the local environment. In aviation this calls for changes in airport designs and materials used, aircraft approach procedures that ensure minimum fuel burn and waste disposal strategies that are economically friendly. Economic sustainability thus
establishes business stability and productivity in the long run. This ensures the business has a future and continues to contribute to the financial welfare of stakeholders, the employees, and the community as a whole. Aviation has contributed greatly to economic development, with a global economic impact estimated at $3,650 billion (International Air Transport Association, 2012).

**Social sustainability.** Social sustainability is based on how behavior, attitudes, choices and/or actions, directly or indirectly impact others. It covers basic needs of safety, freedom and dignity to the broader aspects of business operations and the effect that they have on customers, stakeholders, employees, local and global communities. The social dimension of sustainability in aviation captures the impact of airport activities on societies surrounding it. Apart from providing both employment and business opportunities for local communities, airports provide an operational base for one of the most affordable and safest means of long distance public transportation across geographical barriers that may otherwise be insurmountable.

**Environmental sustainability.** Environmental sustainability deals with factors and practices that affect the environment. The ability of the ecosystem to maintain ecological processes, biodiversity and productivity into the future depends on attitudes and actions of the very people who benefit from it. This demands responsibility (from airports and others) in the proper use of natural resources through investing in alternatives, the application of latest technologies in order to keep harmful emissions at a
minimum, and the proper disposal of waste products in order to keep them from devastating nature.

**Purpose of the Study**

The purpose of this thesis is to investigate emerging trends in sustainability practices and challenges faced by management in efforts to create and maintain a sustainable environment as governed by regulations in aviation. The growth of aviation related activities have resulted in a positive and significant expansion of aviation infrastructure, creating extensive benefits that have included employment, business, commerce, trade, tourism and community prosperity and pride. Unfortunately, the adverse side effects of increased airport operations have been linked to waste products and water, noise and land pollution, which cause health and safety concerns.

This study will focus on awareness and operational changes that have been undertaken at the four commercial service airports in Northern Ohio. Existing efforts will be reviewed as well as the implementation of any policies and programs applied towards creating a sustainable environment. It is the expectation of this study to make a valuable contribution towards understanding and addressing many of the sustainability issues faced by management at commercial service airports.
CHAPTER 2

Literature Review

Aviation related activities at airports have grown exponentially over the past half century, thus demonstrating a strong growth rate as compared to other modes of travel. In the last 35 years, mobility provided by the U.S air transportation system has increased six-fold (Waitz, Townsend, Cutcher-Gershenfeld, Greitzer & Kerrebrock, 2004) because airports provide access to networks that transport people and goods (Nettey, 2007) almost anywhere in the world. As such, they contribute to the prosperity of the communities they serve and create opportunities for employment, business, commerce, trade and tourism as well as development and cross-cultural understanding (Sustainability Reporting Guidelines, 2011). Due to the increased demand, aviation infrastructure has significantly expanded, causing both the direct and indirect impacts to grow considerably.

According to a report published by the Federal Aviation Administration (FAA), the sale of goods and services in the United States tied directly and indirectly to civil aviation contributed $1.3 trillion in 2009, about 5.2% of the nation’s total gross domestic product (Federal Aviation Administration, 2011). Civil aviation in the U.S. remains the single largest positive contributor to the nation’s balance of trade, exporting $70.5 billion and importing $22.2 billion in relevant products in 2009, a net surplus of $48.3 billion (U.S. Census Bureau, 2009, cited in Aerospace Industries Association, 2010). Aviation currently sustains 12 million jobs, which are inclusive of highly skilled and high technology positions. The International Air Transport Association (IATA) estimates that
aviation generates 32 million jobs worldwide with a global economic impact of about $3,650 billion (International Air Transport Association, 2012).

The above benefits do not come without a cost. While airports provide a valuable and unique contribution to the sustainable development of immediate communities and the global society in general, they pose significant sustainability challenges. These challenges include adverse impacts on the environment through carbon emissions, which compromise air quality and cause acid rain and create other detrimental environmental changes. Other effects include waste products and water, noise, and land pollution which causes health and safety concerns to those who work at airports and to the surrounding community. With demand for air transport continually growing and with it the pressure on airports to expand operations in order to accommodate and ease commercial travel, these negative impacts are becoming quite significant (Government Accounting Office, 2000).

**Sustainability: A Contemporary Cause**

The toll of human interventions on the environment under the guise of development over the early and mid last century has been significant, made worse by rapid industrial growth and consumption. These resource-intensive and consumptive lifestyles brought about negative environmental impacts such as an increase in noise levels, water and air pollution that affected the quality of life for both humans and the ecosystem. The Cuyahoga river in North-east Ohio played a major role in inspiring the adoption of significant pollution control laws in the U.S., which to date affect the running of airports. Caused by human pollution from industrial activities, the river literally
became a fire hazard in 1969, when floating oil, debris and other combustible effluent on the river caught fire, an event which caused profound shock to the nation (Scott, 2009). Even though the Cuyahoga river had caught fire at least half a dozen times before 1950, this particular event of 1969 succeeded in attracting long overdue attention to the extent of pollution on the river in particular, and to the nation’s natural resources in general (Cuyahoga River Fire, 2005; Scott, 2009). The resulting attention and concern for the environmental effects associated with human actions culminated in several water pollution control policies. The incident served as a precursor to the National Environmental Protection Act of 1969 as well as the Clean Air Act of 1970 and the Clean Water Act of 1972 (Cuyahoga River Fire, 2005; Environmental Protection Agency, 2012b; Environmental Protection Agency, 2012c; Scott, 2009). These bodies today serve to protect human health and the environment through promulgation and enforcement of environmental legislation passed by Congress.

Operational and/or maintenance activities at commercial service airports in Northern Ohio can affect water supply quality. These activities include construction or seasonal airport anti-icing or de-icing activities. The biological or chemical breakdown of de-icing chemicals in airport runoff can cause severe ecological demands on receiving waterways. Water quality impacts at airports, if not properly controlled, can adversely affect animal, plant or human populations. Due to amendments to the Clean Water Act the FAA evaluates discharges, especially those having the potential to affect navigable waterways, municipal drinking water supplies, or protected ground water supplies.
Vehicles that run on fossil fuels and are used to access and operate airports are the main sources of air pollution generated by the operation of commercial service airports. The demand for parking is a chief concern among airport officials because the increase in congestion and emissions affect air quality (Government Accounting Office, 2000). Such increase in traffic congestion and the associated effects of amplified emissions around airports brings uncertainties on how to comply with the Clean Air Act (Government Accounting Office, 2000).

**History of Sustainability**

The contemporary concept of sustainability has been around for about 40 years, having been highlighted in a mandate adopted by the International Union for Conservation of Nature (IUCN) in 1969, to enforce the possibility of achieving both economic and industrial development without environmental degradation (Adams, 2006). The term was used to prompt humanity’s increasing awareness that any action, whether physical or non-physical, has some sort of systematic effect on the human and/or natural environment (Kates, Parris & Leiserowitz, 2005; Rifkin, 2005).

In 1972, the United Nations Conference on the Human Environment met in Stockholm to emphasize the need for understanding and controlling changes in ecological systems. They also addressed the acceleration and dissemination of environmentally sound technologies and developing alternatives to existing harmful technologies (United Nations Environmental Program, 1972). It was not until the 1980s when the term “sustainability” entered the global debate (Rifkin, 2005), and resulted in the contemporary construct of sustainable development thinking. A meeting held by the
World Conservation Strategy in 1980 helped in the further evolution of this term by emphasizing that:

human beings in their quest for economic development and enjoyment of riches of nature, must come to terms with the reality of resource limitation and the carrying capacities of ecosystems, and must take into account the needs of future generations. (World Conservation Strategy, 1980, ¶ 1).

The increasing concern over the state of the environment prompted a former Prime Minister of Norway, Gro Harlem Brundtland, under instructions of the United Nations Secretary General, to organize and chair the World Commission on Environment and Development to discuss global environmental problems (United Nations, 1987). The Brundtland Report, famously known as “Our Common Future,” resulted from this conference. The report stressed the importance of sustaining economic development without harming the environment and exhausting natural resources. A key statement on sustainable development was provided, defining it as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 1987, ¶ 1).

In 1992, a report by the United Nations Conference on Environment and Development alleged that human beings were at the center of concerns for sustainable development and were entitled to a healthy and productive life in harmony with nature. It further recognized the integral and interdependent nature of the earth and set out to protect the integrity of the global environment and its system of development (United Nations, 1992). With the increase in the use of technology and knowledge of its effects
on the environment, there has come a sharper awareness of how isolated and individual actions can affect the collective well-being. As a result, humanity needs to undertake initiatives to mitigate the negative impacts resulting from current societal and industrial undertakings (Adams & Jeanrenaud, 2008).

**Defining Sustainability**

The word “sustainability” is fairly common and widely recognized in many parts of the world. It has been a topic of contention in the scholarly world and has been discussed in countless articles in the press. As such it has seen various definitions depending on political and scientific viewpoints. As stated previously in this report, the Brundtland Report defined sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” (United Nations, 1987, ¶ 1). Despite this definition, skeptics have questioned the anthropogenic degradation of the natural environment. It has also been claimed that there is a lingering presumption of vagueness, inherent in this definition (Adams & Jeanrenaud, 2008). Daly and Townsend (1993) seem to support this idea and contend that the Brundtland Report’s definition was sufficiently vague to allow for a broad consensus. On the other hand, Kidd (1992) claims that the concept of sustainable development lends itself to a variety of political and scientific roots, and as such has no single definition.

A report by Adams (2006) stated; “The Brundtland definition was neat but inexact. The concept is holistic, attractive, elastic but imprecise. The idea of sustainable development may bring people together but it does not necessarily help them to agree on goals” (p.3). Understandably, the term sustainability covers a complex range of ideas.
There are those who believe that it is this ambiguity in the definition that has prompted its
worldwide acceptance, making it flexible enough for diverse groups, organizations and
institutions to project their own hopes and goals. Essentially the term focuses on two vital
issues: the problem of environmental degradation that so commonly accompanies
economic growth, and the need for such growth to alleviate poverty (Adams, 2006). This
is evidenced in the discussion that resulted in the Brundtland report, which centered on
preserving the environment within an economic and political framework while the focal
point of the Rio\textsuperscript{2} Conference was on global environmental change, and the problems of
biodiversity, resource depletion and climate change (Adams, 2006).

While the debate between economists, politicians, environmentalist and others
may linger on what is to be sustained and how it should be sustained, they all share a
common concern, the fate of the earth. Thus the ideas of sustainability will always be
associated with the natural environment, and with the measure of humanity’s demand on
it for necessities such as food, travel, and energy development or what is referred to as
bio capacity (Collins, Flynn, Wiedmann & Barrett, 2006). Ultimately, the brilliance of
the sustainable development idea is its endeavor to reconcile conflicts that arise between
economic activity and the environment and between the present and the future.

\textsuperscript{2} Rio was the venue for the first United Nations Conference on Environment and Development (UNCED
Earth Summit). The meeting led to the adoption of Agenda 21, which provides a comprehensive action
program to achieve sustainable development and address environmental and developmental issues in an
integrated manner at global, national and local levels.
Sustainability at Airports

Sustainability at airports involves taking responsible sustainable actions that will maintain economic growth, reduce environmental impacts and provide social progress that is consistent with the needs of surrounding communities. The Transportation Research Board (TRB) in its 2005 conference proceedings, visualized sustainability at its most basic level as “one that meets the transportation and other needs of the present without compromising the ability of future generations to meet their needs” (Transportation Research Board, 2005, p.3), thus adopting the universal Brundtland Report definition. A report by the Airport Cooperative Research Program (ACRP) defines airport sustainability as “a broad term that encompasses a wide variety of practices applicable to the management of airports” (Transportation Research Board, 2008, p.3). This thesis recognizes sustainability practices and initiatives around airport operations in the key sustainability areas: economic, environmental and social.

**Economic aspects:** Includes factors such as local hiring, purchasing, and contribution to the surrounding community that have a direct and indirect economic benefit to the region. For this reason, many businesses view the presence of a local airport as essential to their business practices.

**Environmental aspects:** Refers to the natural resources that are used or affected as a result of airport operations and the potential impacts on the ecosystem in which the airport is located, specifically the water and air quality, and waste and recycling operations.
Social aspects: Airports are known to engage in community outreach programs which include educational and social events aimed at fostering relations and promoting good will between the airport and the neighboring communities. They also sponsor fairs that emphasize environmental protection by including activities that may be in the form of sustainability practices, e.g. recycling activities in neighborhoods around the airport. Other broad sustainability concepts initiated include home buyback programs to reduce the adverse impact of aviation noise on residents whose houses may be too close to the airport (Nettey, 2007).

Without question, airport activities and operations are tightly coupled to the well-being of the human and natural environment; as such, air transportation businesses and airport operators must be particularly mindful of their roles in society, and must manage the resources at their disposal with some degree of economy. Overall, as airports undertake an effort to define sustainability and initiate a program, the rationale for undertaking this effort must be understood by those responsible for the development and operations activities.

Environmental Issues Facing Airports

The chief environmental issues facing airports are noise pollution, water quality and air quality. These will be discussed since the direct or indirect negative effects on the surrounding environment (due to activities unique to airports) get manifested in these three key issues. Aircraft operations, de-icing and anti-icing of aircraft and airfields, the operation and maintenance of ground service equipment (GSE), airport facility operations and maintenance, fueling and fuel farms for aircraft and airport vehicles, all affect the
local air and water quality and bring about elevated noise levels, which are a nuisance to
those living around the airport. Other factors that also contribute to the degradation of the
local environment include passenger vehicles to these airports, airport passenger transport
and construction activities. The impacts will intensify with increase in demand for air
colorful and corresponding growth in air transportation service at airports.

**Noise pollution.** Noise from aircraft engines is the most significant environmental
challenge facing airports and will remain the biggest concern in the future, because of the
expected increase in operations (Government Accounting Office, 2008). In most cases,
mitigation strategies from airports and airlines to help reduce the impact of aircraft noise
has not satisfied all surrounding communities.

Aircraft noise impacts the quality of life for the increasing residential populations
living near airports. A report released by the General Accounting Office stressed the
importance of the reduction of aviation noise for efficient operation and expansion of the
National Airspace System (Government Accounting Office, 2008). In looking for
solutions to the noise problem, some older aircraft have been modified through the use of
hush kits to make them quieter (Whitehouse, 1999). An FAA official responsible for
technology issues related to aircraft noise acknowledged that, hush fitted aircraft are still
louder than new aircraft in the same weight range. So far, both FAA and National
Aeronautics and Space Administration (NASA) have set technological goals for reducing
aviation noise at a level of 4 % yearly. This has been necessitated by the increase in air
congestion in order to accommodate the nation’s rapidly growing demand for air travel,
while at the same time avoiding community opposition to aviation noise, a major obstacle
to airport and runway development (Government Accounting Office, 2008). Despite improvements in technological advancements to aircraft and some operational changes, noise continues to be a significant nuisance for some because of increased operations concentrated at a small number of airports.

**Water quality.** Storm water runoff at airports may result in the discharge of pollutants into water bodies on and near the airport. The spillage of fuel, grease, oil lubricants and hydraulic fluids, which leak onto the pavement from service vehicles, operational vehicles, maintenance vehicles and aircraft have been a concern for local communities because these end up in water ways and sewage or drainage systems that run into streams, swamps or rivers if they are not arrested and treated. Similarly, for safe flight operations, the critical surfaces on an aircraft have to be de-iced and anti-iced. Surfaces used for the taxi, takeoff and landing of aircraft must be kept free from ice and snow. For these operational surfaces, mechanical equipment may be used followed by chemical applications further increasing the toxins that end up in the storm water systems. Some glycol based chemical products, are highly soluble and rapidly biodegradable, threatening aquatic life as they break down in water by consuming oxygen. A number of airports have opted for less polluting alternatives for runways and instead use potassium acetate or calcium magnesium acetate, both approved by the FAA and, according to the EPA, have no significant negative impact on water quality (Government Accounting Office, 2000).

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3 Common pavement de-icing and anti-icing agents include ethylene glycol, propylene glycol, urea, an ethylene glycol-based fluid known as UCAR (contains approximately 50% ethylene glycol, 25 % urea and 25% water by weight) potassium acetate, sodium acetate, sodium formate and calcium magnesium acetate (CMA) (Environmental Protection Agency, 2010).
The Clean Water Act of 1972 and its amendments have established water quality goals for the navigable (surface) waters of the U.S. Under this Act, the Environmental Protection Agency (EPA) administers the National Pollutant Discharge Elimination System (NPDES) permit program, designed to regulate discharges of storm water and wastewater (Environmental Protection Agency, 2012a). Storm water discharges are considered point sources and require coverage by an NPDES permit, a must for all airports due to the nature of their operations (Environmental Protection Agency, 2012a; Environmental Protection Agency, 2012e; Luther, 2007). To obtain such a permit, an airport must provide quantitative analytical data identifying the types of pollutants present in its discharges. The permit sets conditions and limits on the airport’s pollutant discharges. As a result, airports try to minimize access of these toxic wastes to local streams by erecting retention ponds, thus containing them before they can get into the local water supply. The contaminants are then treated or diluted to acceptable levels before being released into local water systems. The greatest challenge for airports is how best to deal with storm water runoff, given the expanse of land owned by most airports (Luther, 2007). Depending on location, differences exist among airport NPDES permits.

Since airports need to store fuel for the refueling of aircraft and airport ground service equipment, most are required to develop a Spill Prevention, Control, and Countermeasure (SPCC) plan. The spill control requirements are designed to ensure that facilities that store oil have planned for and taken measures to prevent environmental damage resulting from oil spills (Luther, 2007).
**Air quality.** On any given day, there are numerous commercial service flights in the skies of the U.S. Apart from the aircraft there are various ground vehicles found at airports that rely on fossil fuels. The vehicles include ground support equipment used at airports, such as aircraft towing, baggage-handling, maintenance/repair, refueling, and food service vehicles, as well as those used solely to transport passengers. All these affect the local air quality with potential to become a major problem if not addressed. In most cases, determining the quality of the air is based on the concentration of pollutants from both natural and manmade sources. The Clean Air Act of 1963 (which evolved from the Air Pollution Control Act of 1955) was given the responsibility to protect and improve the nation's air quality (Environmental Protection Agency, 2012b). Through this Act, the EPA established the National Ambient Air Quality Standards (NAAQS) (Environmental Protection Agency, 2012d). This body in turn establishes standards for the amount of pollutants that may be present in the air, and regulates them to ensure that a healthy lifestyle can be sustained by those living in and around the airport, including wildlife.

Aviation is also under pressure to control emissions from aircraft engines. Of major concern are the greenhouse gas (GHG) emissions and their contribution to climate change. Emissions from aircraft engines, even at high altitudes, have an adverse effect on the local air quality. In targeting emissions at high levels, the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), required the industrialized countries to reduce their global carbon footprint collectively (United Nations, 1998). The International Civil Aviation Organization (ICAO) in 2011 requested continued policy options in aircraft engine emissions reductions and called for proposals
and advice in providing technical solutions as they pertain to both industrialized and
developing countries (International Civil Aviation Organization, 2011).

It has been estimated that total aviation (domestic and international) Carbon Dioxide (CO₂) emissions represent approximately two per cent of all global CO₂ emissions (General Accounting Office, 2009). Although the contribution of aviation emissions to total global CO₂ emissions is relatively small, civil aviation in 2009 set for itself an ambitious goal of carbon neutral growth (CNG) by 2020 and beyond (International Air Transport Association, 2009). Achieving such an aggressive goal demands a multi-faceted approach that covers more fuel-efficient operational practices that include, aircraft fuel efficiency, alternative fuel technologies and market based mechanisms, such as carbon trading schemes and other more innovative approaches.

**Sustainability Drivers**

Sustainability is becoming a big issue for airports leading to factors that influence the motivation behind sustainability initiatives by airport operators. A survey by ACRP sought to identify the main driving forces behind sustainability practices for both current and future drivers (Transportation Research Board, 2008). The report’s intention was to inform airport operators, stakeholders, and policy makers about a range of airport sustainability practices across the triple bottom line of environmental, economic, and social issues (Transportation Research Board, 2008). The following figure summarizes their findings.
Figure 3: Current and future drivers for sustainability

<table>
<thead>
<tr>
<th>Rank</th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>State/regional Regulations</td>
<td>Stakeholder Concerns/Relations</td>
</tr>
<tr>
<td>2</td>
<td>Airport Policy</td>
<td>Global Trends</td>
</tr>
<tr>
<td>3</td>
<td>Federal Regulations</td>
<td>Airport policy</td>
</tr>
<tr>
<td>4</td>
<td>Corporate Responsibility</td>
<td>Corporate Responsibility</td>
</tr>
<tr>
<td>5</td>
<td>Stakeholder Concerns/Relations</td>
<td>Federal regulations</td>
</tr>
</tbody>
</table>

According to the reported responses, state/regional and federal regulations emerged as the current key driver for implementation of sustainability practices at airports, along with airport policies, corporate responsibility, and stakeholder concerns/relations (Transportation Research Board, 2008). This response raises an important question. If airports engaged in sustainability practices because of state and federal regulations, to what extent would they still engage in these activities in the absence of these regulations? The answer may be found in observing the future drivers according to the survey. Stakeholder concerns/relations closely linked with global issues (such as climate change) were identified as the most common drivers for implementation of airport sustainability practices and programs in the future. This thesis assumes that the concern for the environment, combined with social concern and factors like corporate responsibility, would provide enough incentive for airports to still consider sustainability initiatives in the absence of government regulations. This thought is further backed by the Airports Council International - North America’s (ACI-NA) 2008 commissioned Environmental Benchmarking survey. The results indicated that airports have undertaken

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4 Source: ACRP Synthesis 10: Airport Sustainability Practices (Transportation Research Board, 2008)
extensive and innovative measures to improve environmental performance without regulatory mandates because of their concern for the health of the environment and the people living in it (Airports Council International-North America, n.d).

**Sustainability policies and programs.** At present among the leading factors forcing airports to take the issue of sustainability seriously are federal, state and local government directives that require airports to become more sustainable and accountable. Airport pilot programs and environmentally tailored research and development funding are among the provisions in the FAA reauthorization legislation (HR 915) passed by the House Senate in 2009. The legislation among other things:

i) Gives a grant allowing airports to use Airport Improvement Program (AIP)\(^5\) funding to review flight procedures used in noise abatement programs.

ii) Allocates funding for the development of continuous lower energy, emissions and noise (CLEEN) engine and airframe technology. The aim is to allow an entity to develop a more efficient engine and airframe technology that would reduce energy consumption, emissions and noise.

iii) Includes the development of certifiable aircraft technology, for the reduction of noise levels within the 48 contiguous states and to determine the feasibility of alternative fuels in aircraft systems and the extent to which new engine and aircraft technologies may be used to retrofit aircraft.

\(^5\) AIP was established by the Airport and Airway Improvement Act of 1982 (Public Law 97-248). Funds are drawn from the Airport and Airway Trust Fund supported by passenger tickets, fuel taxes and other fees. The Act has seen several amendments with the most recent being Vision 100 – Century of Aviation Reauthorization Act of 2003.
iv) Directs the FAA to fund pilot programs at six airports to research ways to lessen aviation impacts on noise, air quality, or water quality.

v) Mandates the FAA to fund pilot programs at five airports to design, develop and test air traffic management technologies and to lessen the length of ground holds and idling time for aircraft, for the reduction of emissions and better fuel savings (Airports Council International-North America, n.d., p.5).

Airports are also required to address the feasibility of solid waste recycling and minimization of waste generation in their Master Plans as a condition of the approval of the AIP development project as stipulated in the FAA Reauthorization Act of 2009.

The Voluntary Airport Low Emissions (VALE) Program, (under Vision 100 Century of Aviation Reauthorization Act of 2003) intends to reduce airport ground emissions and allows the use of AIP and Passenger Facility Charges (PFCs)\(^6\) to finance low emission vehicles, gate electrification, and other airport air quality improvements. In addition, the Noise Compatibility Program aims to address noise made by the airport’s operations and to identify land use strategies that can reduce the incompatibilities of excessive noise on surrounding communities.

In 2010, the FAA introduced, the Sustainable Master Plan Pilot Program at 10 chosen airports, which is scheduled to end by late 2012. By evaluating ways to make sustainability a core objective, the “Sustainable Master Plans and Sustainable Management Plans” will include proposals for the reduction of environmental impacts.

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\(^6\) PFC programs allow the collection of fees up to $4.50 for every enplaned passenger at commercial airports controlled by public agencies. Airports use these fees to fund FAA approved projects that enhance security, safety or capacity or the reduction of noise among other things.
and realization of economic benefits while enhancing integration with the local community (Federal Aviation Administration, 2012).

In the recent past, trade associations in aviation, specifically, airports, airlines and airframe manufactures, have formed a coalition to find collaborative ways of improving environmental performance and ensuring sustainable growth. An example is ACI-NA, which works together with international, federal and state/local entities and airlines to respond to environmental concerns. Some identified sustainable practices include energy conservation and green buildings and initiatives such as Leadership in Energy and Environmental Design (LEED) certification. Thus far several airports have proactively taken steps to reduce the effect of their operations. San Diego International Airport, Daytona Beach International Airport and Dallas/Fort Worth International airport, among others, have identified projects and programs that minimize the impact of those activities within their control.
CHAPTER 3

Methodology

This research effort sought to answer the question: “How aware are the commercial service airports in Northern Ohio about the sustainability challenges they face and what are the operational changes adopted to alleviate these challenges?” To answer this important question, the four commercial service airports in Northern Ohio—Cleveland Hopkins International Airport (CLE), Akron Canton Regional Airport (CAK), Youngstown-Warren Regional Airport (YNG) and Toledo Express Airport (TOL) - were identified as subjects for this empirical study. Purposive sampling was employed to select four individuals, one from each airport, to complete the survey instrument for this research effort. Selection was based on their knowledge of sustainability practices related to airport operations and management at their respective airports.

Data Collection

Given that this was an empirical study, a survey questionnaire was employed as the primary tool for data collection. The initial contact with the respondents was made through a mailed package which contained a Letter of Introduction (see Appendix A) and an Informed Consent Form (see Appendix B). The Informed Consent Form also served to explain what the study entailed. Attached to these were the Survey Questions (see Appendix C) intended to be completed at the convenience of the respondent. As an incentive to expedite the return of the completed questionnaire and also to alleviate
postage costs on the respondent, an envelope with a return address and pre-paid postage was included in the survey package.

**Procedures.** The questions were carefully selected with the goal of seeking how the particular airport had gone about the implementation of policies and programs associated with awareness of sustainability practices at their respective airports. To achieve this, the survey questions were grouped into five areas labeled from A to E, with each area addressing a unique aspect of sustainability. The five areas were: (a) *Awareness of sustainability*, concerned with finding out staff awareness, training and information dissemination on sustainability. (b) *Aircraft and vehicular emissions in the vicinity of airports*, sought to address air quality and steps taken to curb emissions. (c) *Storm water runoff*, set out to discover the airport’s handling of storm water, deicer-impacted runoff and general water quality around the airport. (d) *Airport noise pollution*, whose aim was to identify the airport’s goals for noise reduction levels and its key components of the noise abatement program, if any. (e) *Regulations governing environmental issues at airport* involved discovery of the airport’s awareness as well as compliance with applicable environmental regulations and standards, as set forth by the FAA and the EPA.

The questions under these areas required the respondents to select the option that best reflected the practice at the particular airport that the question was addressing. Respondents were required to choose from the answer choices given, which were “Yes”, “No” and “N/A” (not applicable). In two of the areas of the questionnaire, respondents were required to give a list of items pertaining to that particular area. It was expected that respondents would take no more than one hour to complete the survey. Respondents were
further informed that there were no direct individual benefits to this study. The potential benefit of the study is its contribution towards understanding and addressing many of the sustainability issues faced by management at commercial service airports.

**Data Analysis**

Since data collected adhered to the nominal level of measurement, the actual analysis involved the running of frequencies to reflect the number of times a particular answer was selected by respondents. These frequencies were analyzed and presented in a table format. The responses are anonymously presented as Airports A to D. The proportion of those who said “Yes” was calculated and incorporated in the table. An analysis of each area is presented as a brief summary of the findings.

**Area A: Awareness of sustainability.**

Table 1 (on the next page), summarizes the first series of questions (Area A), which addressed Awareness of Sustainability. As illustrated on the Table, 50% of the respondents indicated that there was a person assigned to deal with sustainability issues at their airports, 25% did not have an assigned person and the remaining 25% specified that this did not apply to them. Adequate training applied to only 25% of the respondents, while for the rest it did not or, was not applicable. The same 25% indicated that their staff was intimately involved in sustainability matters. Interestingly 50% of the respondents claimed to providing sustainability information to the airport community.
Table 1

# Awareness of Sustainability

<table>
<thead>
<tr>
<th>Questions</th>
<th>Airport A</th>
<th>Airport B</th>
<th>Airport C</th>
<th>Airport D</th>
<th>Proportion of Yes Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there a person assigned to deal with sustainability issues at your airport?</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>50%</td>
</tr>
<tr>
<td>2. Do you believe adequate training on sustainability is provided to your employees?</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>25%</td>
</tr>
<tr>
<td>3. Is your staff intimately involved in sustainability matters?</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>25%</td>
</tr>
<tr>
<td>4. Do you provide useful sustainability information to the entire airport community including businesses (airport tenants) that operate at the airport?</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>50%</td>
</tr>
</tbody>
</table>

This disparity came from airport B which had specified that staff training and involvement in sustainability did not apply to the airport, yet indicated to providing information to the airport community.

Question 5 in this section (Area A- Awareness of sustainability) asked the respondent to list sustainability practices that their airport takes part in. Of the listed choices, reduction of waste products -through recycling- was preferred by 75% of the respondents with 50% admitting they were practicing energy conservation methods. Other mentioned practices were landfill reduction, storm water compliance and sustainable floors (made from terrazzo), that could last up to 100 years with minimal maintenance.
Area B: Aircraft and vehicular emissions in the vicinity of airports.

Table 2 provides the answers given by respondents to questions relating to aircraft and vehicular emission within the airport’s vicinity.

Table 2

<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses n=4</th>
<th>Proportion of Yes Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area (B) Aircraft and Vehicular emissions in the vicinity of airports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Does your airport have a vehicular and aircraft emissions reduction plan?</td>
<td>No No No Yes</td>
<td>25 %</td>
</tr>
<tr>
<td>2a. Does your airport <em>monitor</em> air quality within the airport vicinity?</td>
<td>No No Yes Yes</td>
<td>50 %</td>
</tr>
<tr>
<td>2b. If yes, does the airport <em>manage</em> air quality within the airport vicinity?</td>
<td>N/A N/A No Yes</td>
<td>25 %</td>
</tr>
<tr>
<td>3. Does your airport take steps to reduce customer wait times and vehicular congestion around the terminals from personal vehicles?</td>
<td>N/A N/A No Yes</td>
<td>25 %</td>
</tr>
<tr>
<td>4. Does your airport require airport taxi cabs and bus companies to comply with clean burning fuels as an alternative to fossil fuels?</td>
<td>No N/A No No</td>
<td>0 %</td>
</tr>
<tr>
<td>5. Does your airport use clean burning fuels for ground support equipment vehicles?</td>
<td>No No No No</td>
<td>0 %</td>
</tr>
</tbody>
</table>

As revealed in Table 2, only 25% of the respondents acknowledged that they had an emissions reduction plan at their airports; with the remaining 75% claiming they did not have an emissions reduction plan. Those who allegedly monitored air quality around their vicinity were 50%, and those who management it were said to be 25%. Only 25% of the respondents took steps to reduce customer wait times and vehicular congestion at their airports. None of the respondents required taxi cabs and bus companies operating within
the airport to comply with clean burning fuels as an alternative to fossil fuels, and they
did not use clean burning fuels for ground support equipment vehicles.

**Area C: Storm water runoff.**

Table 3 reflects respondents’ answers to their airport’s handling of storm water,
deicer-impacted runoff and general water quality around the airport.

Table 3

*Storm Water Runoff*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses n=4</th>
<th>Airport A</th>
<th>Airport B</th>
<th>Airport C</th>
<th>Airport D</th>
<th>Proportion of Yes Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does your airport collect storm water for treatment before release?</td>
<td></td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>50 %</td>
</tr>
<tr>
<td>2. Does your airport provide facilities for deicer-impacted runoff collection?</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>100 %</td>
</tr>
<tr>
<td>3. Does your airport have on-site wastewater treatment facilities?</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0 %</td>
</tr>
<tr>
<td>4. Does your airport have plans to eliminate the use of glycol products?</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0 %</td>
</tr>
<tr>
<td>5. Does the community / local authorities complain about water quality?</td>
<td></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>0 %</td>
</tr>
</tbody>
</table>

As the Table indicates, 50% of the respondents claimed to comply with storm water
treatment before it was released, while 25% apparently did not. All of the respondents
(100%) allegedly provided facilities for deicer-impacted runoff collection, and all of them
did not have an on-site wastewater treatment facility. None of the respondents had any
plans to eliminate the use of glycol products in the near future and none had any
complaints from the community or local authorities on water quality.
Area D: Airport noise pollution.

Table 4 provides the answers given by respondents to questions relating to their airport’s noise pollution and counter measures.

Table 4

Airport Noise Pollution

<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses n=4</th>
<th>Proportion of Yes Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area (D) Airport noise pollution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Does the community / local authorities complain about noise levels?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Has the airport set goals for reducing aviation noise levels?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3. Does your airport have programs to compensate noise affected residents?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Does your airport have a noise abatement program?</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

In Table 4, 75% of the respondents affirmed they had received noise complaints from the community or local authorities. Half of the respondents (50%) claimed to have set goals for reducing the noise levels at their airport. These same respondents (50%) alleged they had programs to compensate for noise affected residents and consequently they were the same respondents who laid claim to a noise abatement program.

Question 5 in this area (Area D- Airport noise pollution) required the respondents to “Briefly state the key components of your airport’s noise abatement program.” Half of the respondents (50%) laid out their specific plans. These plans included a designated flight corridor to be observed at certain times of the day, a designated flight corridor to be followed between the hours of 11:30 PM – 5:30 AM (both created purposely for noise
reduction impact on residences), a specific location for engine run-ups by maintenance personnel and a program aimed at sound proofing noise affected residences.

**Area E: Regulations governing environmental issues at airports.**

Table 5 was concerned with the respondents’ responses to compliance with applicable environmental regulations and standards, as set forth by the FAA and the EPA.

Table 5

*Regulations Governing Environmental Issues at Airport*

<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses n=4</th>
<th>Proportion of Yes Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (E) Regulations governing environmental issues at airports.</td>
<td>Airport A</td>
<td>Airport B</td>
</tr>
<tr>
<td>1. Does your airport’s operations comply with the National Ambient Air Quality Standards (NAAQS) (see enclosed) as set forth by the EPA?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Does your airport’s operations comply with the National Pollutant Discharge Elimination System (NPDES) Permit (see enclosed) as set forth by the EPA?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3. Does your airport’s operations comply with applicable noise standards of 65 db as established by the FAA?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Does your airport develop policies that address sustainability issues at the airport?</td>
<td>N/A*</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Does your airport develop strategies to help achieve short, medium and long term sustainability targets?</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*The airport is currently engaged in a review of their master plan. The new master plan will feature noise exposure maps delineating better noise contour levels.*
As established in Table 5, 75% of the respondents acknowledged complying with the National Ambient Air Quality Standards (NAAQS) as set forth by the EPA. All (100%) of the respondents, disclosed compliance with the National Pollutant Discharge Elimination System (NPDES) Permit, as expected since it sets conditions and limits on the airport’s pollutant discharges. All (100%) respondents also revealed their compliance with applicable noise standards of 65 decibels as established by the FAA. Half (50%) of the respondents were developing policies to address sustainability issues at their airports, while this did not apply to the remaining 50%. Out of all the respondents, only 25% had strategies aimed at achieving short, medium and long term sustainability targets at their airport facilities.
CHAPTER 4

Findings

The findings indicate that, while most airports acknowledge they are aware of sustainability, the scale of their operation appears to be the determining factor of whether they have an assigned person with responsibility for sustainability. Apparently, the smaller operations have no need to assign a person since their activities are not substantial enough to justify this, while for the largest of these operations, multiple personnel may address the matter of sustainability. Of the listed sustainability practices, the recycling of waste products serves a dual purpose, that of cost containment and the environmental concern. Energy efficiency appears to be a major focus at some airports and these are considering both energy supply and consumption.

The preceding results suggest that air quality monitoring and measuring is only feasible in large operations where there is a danger of air pollution, and where the EPA is quite vigilant in ensuring compliance. Since the majority of commercial service airports in Northern Ohio have moderate daily operations, the danger of them contributing a significant amount of pollution, is minimal, hence the lack of air monitoring and management. None of the airports required compliance by taxi cabs and bus companies to use alternative fuels due to the lack of infrastructure to support this venture. Even so, 25% of these airports disclosed that the buses operating to and from the airport were using clean burning fuel as a county requirement.
Storm water collection is associated with the scale of operations and the daily activities at these airports (50%). Such activities -maintenance of ground service equipment (GSE), airport facility operations and maintenance, fueling and fuel farms for aircraft and airport vehicles- have the potential to affect waterways and water supplies. To ensure compliance with the Clean Water Act, these larger operations treat their water before release to outside water sources. Hence there were no complaints received on the water quality by the surrounding residents or the local authorities. On-site wastewater treatment is done by the city government, and none of the respondents have plans to eliminate the use of glycol products, possibly because there are no practical and economic alternatives.

Most of the surveyed airports (75%) affirmed receiving noise complaints from the community or local authorities, even though they all are operating within the legal limits set forth by the FAA. As a result, half of them have noise abatement programs in place to combat this problem. Such programs include a designated flight corridor to be observed at certain times of the day created purposely for noise reduction impact on residences. One of the respondents expected airline pilots to maintain runway heading until 2000 feet above Mean Sea Level or for three nautical miles before turning on course whenever possible, while another had a requirement for night operations to stay on specific runway headings for the final four miles on approach. Also, 50% of the respondents had specific locations for airline maintenance personal to perform engine run-ups within the Airport Operations Area (AOA). A Residential Sound Insulation Program (RSIP) was in place according to one respondent, which set out to sound proof residences located within the
limit of 65 decibels or greater. This program consists of replacing windows, doors, and heating ventilation and air conditioning (HVAV) equipment as outlined by the FAA, with typical sound proofing costs ranging from $30,000 to $60,000 per residential unit.

The majority of the respondents (75%) indicated observing the NAAQS as set forth by the EPA. All of the respondents disclosed compliance with the NPDES Permit, as expected, since it sets conditions and limits on the airport’s pollutant discharges and is a must for all airports in operation. All airports also disclosed their conformity with applicable noise standards of 65 decibels as established by the FAA. There is an implication that sustainability is becoming a core objective in airport planning, resulting in policies to address sustainability matters at the large commercial service airports.

**Other Significant Findings**

Demand for vehicular parking has not been a major problem at commercial service airports in Northern Ohio. Even so, 50% of the respondents have taken the initiative to have a free cell phone parking lot for the convenience of customers waiting to pick up passengers. The main motivation though is to avoid congestion outside the terminal building, than it is for the purpose of limiting harmful emissions. Respondents hope that waiting customers will not leave their engines idling unless it is during inclement winter weather conditions when there is a need to keep warm, or during hot summers for keeping cool.

All the facilities provide for deicer-impacted runoff collection as required by regulations with the large operations using a centralized and separate de-icing pad.
Drainage systems direct the runoff to storage tanks with the capacity to hold millions of gallons of fluid, where the glycol products can either be recovered and recycled (depending on the concentration level) or treated before release.

The majority of the respondents are taking part in energy conservation methods to improve their energy consumption and reduce the associated costs. These respondents are transitioning from the old inefficient lighting fixtures to LED lighting for the airfield, and the use of compact fluorescent lighting for the terminal buildings and parking garages. Also some areas of the terminal buildings are shut down during periods of non-use.

**Challenges**

One of the major challenges faced by airports is that of alternative fuel for airport ground support vehicles. While it is acknowledged that this would be possible, the difficulty arises in where to acquire the alternative fuel from since, there are no known alternative fuel stations in Northern Ohio, as alleged by one respondent. There is also concern that the alternative fuel may not be feasible or available for the engine size and horsepower needed for heavy equipment like those used for snow removal, as well as concern that the type of gas may be highly volatile. The testing of electric cars, while underway in one of the facilities, also poses a challenge when it comes to the use of heavy equipment such as the aircraft pushback tractors or baggage tugs.

Noise pollution continues to be a significant environmental challenge to airports in Northern Ohio. Flight tracking and noise monitoring systems along primary flight corridors- to measure noise levels at certain locations and their impact on the community-
have been installed with the aim of developing better noise contour maps. Even with the newest and most quiet jet aircraft and better noise contours maps, complaints from some in the community still abound. Airports respond by trying to reduce the adverse impact of aviation noise on such affected residents by soundproofing their homes in efforts to be environmentally responsible as well as good neighbors.

A major challenge for airport management involving storm water collection is the large expanse of the airport grounds, especially during the winter months when vital surfaces like runway, taxiways and ramps have to be kept free of ice and snow through the use of chemicals. Consequently one of the respondents affirmed that storm water collection was done on only a portion of the entire airport and only during de-icing season.

Limitations

Since the study targeted commercial service airports in Northern Ohio, the sample was limited to a few respondents. As such, operations in these airports were not comparable in terms of scale, the number of daily aircraft operations (take offs and landings) and the population size of the surrounding neighborhoods. Such differences may have created a different emphasize and motivation in the part played by respondents in determining the sustainable areas to focus on, or not, and the degree of the efforts allocated in the selected sustainable matters.

It is also noted that the policies and practices followed by the airports in the sample are largely driven by local, state and regional environmental regulations and rules, and may therefore limit the inference of this study to other commercial service airports.
CHAPTER 5

Discussion

Since sustainability concerns arise whenever a valued system is threatened with some form of decline or is at risk of not being maintained, airports have been the focus of many in the echelons of governmental and environmental groups.

This study has established that commercial service airports in Northern Ohio are aware of sustainability matters and have taken steps to counter the role they play in the decline of the environment. This is evidenced through trends in responsible practices, the investing in alternative resources and the application of the latest technologies in efforts to keep environmental harm at a minimum. Demands to comply with the sustainable policies result in different degrees of compliance depending on what is of importance, and the scale of operations. Commercial service airports with more operations are under stricter rules and face more challenges due to the scale of their physical surroundings.

In addition, the study has shown that most of the surveyed airports have failed to engage staff and other airport businesses in sustainability matters. Airport management should realize that employee engagement in sustainability initiatives may help align such initiatives with the airport’s goals resulting in better operational efficiency and improved customer relations. In the long run, the application of these initiatives may create goodwill between the airport and the neighboring communities, alleviating some of their concerns and reducing complaints about the airport and its operations.
Conclusions

Public demand for air travel is continually growing. In the interest of sustainability, it is prudent for aviation to improve its environmental performance in order for the economic activities to continue. It is evidently clear that airport operators have to take into consideration the environmental issues associated with aviation as critically important to the future development of aviation infrastructure. Sustainability objectives and strategies therefore provide important guidelines for airports to evaluate their operational practices in terms of their effect on the natural environment, as well as the economic and social well-being of local communities.

Though sustainability may mean different things to different people, in aviation, its meaning has been standardized by the EPA and FAA regulations and other policies that airports are expected to follow. With the desire to comply and contribute to the sustainable policies, challenges are encountered which create opportunities for viable solutions being sought. Such solutions lead to sustainable strategies and innovations of tomorrow. From such strategies come insight on how to use advanced technologies effectively to motivate the development of improved operational practices and increased operational efficiencies.

There is room for more research in the areas of sustainability discussed in this research study. Conclusive findings may result among a larger research sample with comparable daily aircraft operations and size of airport grounds and if possible similar neighborhood demographics. Since airports are a source of community pride and a generator of economic activity for the local, state and national governments, the
responsibility to develop the appropriate strategies, maintain and safely operate the airport asset becomes a great burden to those who manage them. Ultimately, the focus, motivation and balance in the areas of sustainability is unique and specific to each airport and its community because of the differences in their environment.
APPENDICES
APPENDIX A

LETTER OF INTRODUCTION
Dear Mr. __________

My name is Jennifer Mutuku, a Master of Technology thesis student in the College of Technology at Kent State University. My thesis project is entitled “Emerging Trends in Sustainability Practices at Airports: An Analysis of Awareness and Operational Changes at Commercial service airports in Northern Ohio.” My thesis director is Dr. I. Richmond Nettey (330.672.9476), Associate Dean, College of Technology, Kent State University.

This thesis project seeks to review existing efforts at your airport and the implementation of policies and programs that are associated with creating a sustainable environment. It is the aim of this thesis to determine and describe sustainability practices and challenges faced by commercial service airports in Northern Ohio. Attached is a survey to that effect. With your help, the successful completion of the attached survey will not only help towards completing my thesis project, but will also make an important contribution towards knowledge gathering about sustainability issues faced by airport management.

If needed, I would like to come and visit with you to complete the survey. I know your time is of the utmost importance; your assistance in the above matter is therefore highly appreciated. I may be reached at 330.412.5383 or jmutuku@kent.edu. I look forward to your response and your kind assistance in completing the enclosed survey.

Sincerely,

Jennifer Mutuku
Master of Technology
Kent State University
jmutuku@kent.edu
330.412.5383
APPENDIX B

CONSENT FORM
Informed Consent to Participate in a Research Study

Emerging Trends in Sustainability Practices at Airports: An Analysis of Awareness and Operational Changes at Commercial Service Airports in Northern Ohio

Principal Investigator: Jennifer Mutuku

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision. You may make a copy of this document to keep with you.

Purpose
The purpose of the proposed study is to investigate emerging trends in sustainability practices and challenges faced by management in efforts to create and maintain a sustainable environment as mandated by today’s aviation field. The study will focus on awareness and operational changes that have been undertaken at commercial service airports in Northern Ohio. Existing efforts at these airports will be reviewed as well as the implementation of any policies and programs applied in creating a sustainable environment.

Procedures
The survey sample will comprise four employees at the four commercial service airports in Northern Ohio, who will be required to fill out a mailed survey to this effect. Respondents will need one to one and half hours to complete the survey.

Benefits
There are no direct benefits to the individuals involved. The potential benefit of this study is its contribution towards understanding and addressing many of the sustainability issues faced by management at Commercial service airports.

Risks and Discomforts
The study involves no more than minimal risk to the participants.
Privacy and Confidentiality
The information collected will not be identifiable to others. Your signed consent form will be kept separate from your study data and responses will not be linked to you.

Compensation
There is no compensation for participating in this study.

Voluntary Participation
Taking part in this research study is entirely voluntary. You may choose not to participate or you may discontinue your participation at any time.

Contact Information
If you have any questions or concerns about this research, you may contact Jennifer Mutuku at 330.672.0791 or Dr. I. Richmond Nettey at 330.672.9476. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330.672.2704.

Consent Statement and Signature
I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to participate in this study. I understand that a copy of this consent will be provided to me for future reference.

________________________________  ___________________
Participant Signature                Date
APPENDIX C

SURVEY QUESTIONNAIRE
SURVEY QUESTIONNAIRE

Jennifer Mutuku

Emerging Trends in Sustainability Practices at Airports: An Analysis of Awareness and Operational Changes at Commercial Service Airports in Northern Ohio

A) Awareness of Sustainability

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is there a person assigned to deal with sustainability issues at your airport?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>2. Do you believe adequate training on sustainability is provided to your employees?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>3. Is your staff intimately involved in sustainability matters?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>4. Do you provide useful sustainability information to the entire airport community including businesses that operate at the airport?</td>
<td>___</td>
<td>___</td>
<td>___</td>
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<tr>
<td>5. Please list sustainability practices that the airport takes part in.</td>
<td></td>
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</tr>
</tbody>
</table>

B) Aircraft and vehicular emissions in the vicinity of airports

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does your airport have a vehicular and aircraft emissions reduction plan?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>2 a. Does your airport monitor air quality within the airport vicinity?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>2 b. If yes, does the airport manage air quality within the airport vicinity?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>3. Does your airport take steps to reduce customer wait times and vehicular congestion around the terminals from personal vehicles?</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>
4. Does your airport require airport taxi cabs and bus companies to comply with clean burning fuels as an alternative to fossil fuels? __ __ __

5. Does your airport use clean burning fuels for ground support equipment vehicles? __ __ __

C) Storm water runoff

1. Does your airport collect storm water for treatment before release? __ __ __

2. Does your airport provide facilities for deicer-impacted runoff collection? __ __ __

3. Does your airport have on-site wastewater treatment facilities? __ __ __

4. Does your airport have plans to eliminate the use of glycol products? __ __ __

5. Does the community / local authorities complain about water quality? __ __ __

D) Airport noise pollution

1. Does the community / local authorities complain about noise levels? __ __ __

2. Has the airport set goals for reducing aviation noise levels? __ __ __

3. Does your airport have programs to compensate noise affected residents? __ __ __

4. Does your airport have a noise abatement program? __ __ __

5. Briefly state the key components of your airport’s noise abatement program.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
E) Regulations governing environmental issues at airports.

1. Does your airport’s operations comply with the National Ambient Air Quality Standards (NAAQS) (See enclosed) as set forth by the EPA?  
   [ ] Yes [ ] No [ ] N/A

2. Does your airport’s operations comply with the National Pollutant Discharge Elimination System (NPDES) Permit (See enclosed) as set forth by the EPA?  
   [ ] Yes [ ] No [ ] N/A

3. Does your airport’s operations comply with applicable noise standards of 65 db as established by the FAA?  
   [ ] Yes [ ] No [ ] N/A

4. Does your airport develop policies that address sustainability issues at the airport?  
   [ ] Yes [ ] No [ ] N/A

5. Does your airport develop strategies to help achieve short, medium and long term sustainability targets?  
   [ ] Yes [ ] No [ ] N/A
SURVEY ATTACHMENTS
National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m³).

<table>
<thead>
<tr>
<th>Pollutant [final rule cite]</th>
<th>Primary/Secondary</th>
<th>Averaging Time</th>
<th>Level</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide [76 FR 54294, Aug 31, 2011]</td>
<td>primary</td>
<td>8-hour</td>
<td>9 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-hour</td>
<td>35 ppm</td>
<td></td>
</tr>
<tr>
<td>Lead [73 FR 66964, Nov 12, 2008]</td>
<td>primary and secondary</td>
<td>Rolling 3 month average</td>
<td>0.15 µg/m³ (1)</td>
<td>Not to be exceeded</td>
</tr>
<tr>
<td>Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]</td>
<td>primary</td>
<td>1-hour</td>
<td>100 ppb</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>primary and secondary</td>
<td>Annual</td>
<td>53 ppb (2)</td>
<td>Annual Mean</td>
</tr>
<tr>
<td>Ozone [73 FR 16436, Mar 27, 2008]</td>
<td>primary and secondary</td>
<td>8-hour</td>
<td>0.075 ppm (3)</td>
<td>Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years</td>
</tr>
<tr>
<td>Particle Pollution [71 FR 61144, Oct 17, 2006]</td>
<td>PM₂.₅</td>
<td>primary and secondary</td>
<td>Annual</td>
<td>15 µg/m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24-hour</td>
<td>35 µg/m³</td>
<td>98th percentile, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>PM₁₀</td>
<td>primary and secondary</td>
<td>24-hour</td>
<td>150 µg/m³</td>
</tr>
<tr>
<td>Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]</td>
<td>primary</td>
<td>1-hour</td>
<td>75 ppb (4)</td>
<td>99th percentile of 1-hour daily maximum concentrations, averaged over 3 years</td>
</tr>
<tr>
<td></td>
<td>secondary</td>
<td>3-hour</td>
<td>0.5 ppm</td>
<td>Not to be exceeded more than once per year</td>
</tr>
</tbody>
</table>

As of October 2011
(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m³ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard (“anti-backsliding”). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Source: National Ambient Air Quality Standards (Environmental Protection Agency 2012d)
National Pollutant Discharge Elimination System Compliance Monitoring

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal and other facilities must obtain permits if their discharges go directly to surface waters.

In most cases, the NPDES permit program is administered by authorized states. Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our nation's water quality.

Compliance Monitoring

EPA conducts inspections of facilities subject to the regulations to determine compliance. EPA inspections involve:

- reviewing discharge monitoring reports
- interviewing facility personnel knowledgeable of the facility
- inspecting the processes that generate and treat wastewater
- sampling wastewater discharges to navigable waterways and other points in the generation or treatment process
- reviewing how samples are collected and analyzed by the laboratory (More on the Quality Assurance Study Program)

NPDES inspection protocols can be found in Chapters 1 - 7 of the NPDES Compliance Inspection Manual.

The Clean Water Act NPDES Compliance Monitoring Strategy for the Core Program and Wet Weather Sources (PDF) (28 pp, 367K, About PDF) provides inspection frequency goals for the core NPDES program and for wet weather sources including Combined Sewer Overflows (CSO), Sanitary Sewer Overflows (SSO), Concentrated Animal Feeding Operations (CAFO), and Storm Water.

EPA Memorandum of Understanding with US Coast Guard: Collaboration on Compliance Assistance, Compliance Monitoring, and Enforcement of Vessel General Permit Requirements on Vessels (PDF) (11 pp, 298K, About PDF)

Source: National Pollutant Discharge Elimination System (Environmental Protection Agency, 2012e)
REFERENCES
REFERENCES


Nettey, I. R. (2007). Airport Management (TECH 35340) class notes, Kent State University, Kent, Ohio


