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Factors Related to the Assessment of the Effectiveness of Environmental Management Systems (EMS) at Airports

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by

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Abstract

Title: Factors Related to the Assessment of the Effectiveness of Environmental Management Systems (EMS) at Airports

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The purpose of this study was to identify factors that can be used to assess the effectiveness of EMS at airports in the United States (U.S.). A survey research methodology was used for this study in two phases. The first phase of the research study included a preliminary expert opinion survey of airport managers and other individuals acting in a supervisory role to determine and discuss how EMS help improve environmental performance, and ranked factors that may be related to assessing the effectiveness of EMS. The second survey was constructed based on feedback from these experts and targeted airport employees working in a non-supervisory role to obtain their perceptions of EMS' effectiveness based on these factors. These opinions were measured on a Likert-type scale from 1=Strongly Disagree to 5=Strongly Agree. Descriptive statistics were used to help analyze the relevant data and gather conclusions.

Through the research conducted, four main factors were identified namely: compliance with relevant regulations and legislation, improves environmental

performance, cost effectiveness, and improve public image and bring market opportunities. The first and fourth named factors were ranked same in both phases of the survey but the second and third named factors were ranked differently. Specifically, improves environmental performance was ranked second in the first phase, but third in the second phase of the study. Moreover, there were ten specific items could be considered critical factors related to assessing the effectiveness of EMS because the mean scores for these items were 3.5 or higher, meaning participants tended to agree with these items. These findings can provide the guidance for airport management to determine the effectiveness of EMS and provide a practical tool for airport operators to engage in continuous improvement. These factors also could be tailored as, or tied to performance measures for the purpose of strategic planning.

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Chapter 1

Introduction

1.1 Problem Statement

With improving awareness of environmental protection, organizations have considered how their activities and behaviors influence the environment and how to become more environmentally friendly. Environmental Management Systems (EMS) have been used for a relatively long time by manufacturing firms to help them measure their environmental performance and organizations' behavior. Similarly, the growing aviation industry also has considered various ways in which their environmental issues may be managed and has introduced EMS for this purpose. EMS is a comparatively new management system in the aviation industry, especially at airports. So far, very few airports have implemented EMS worldwide. For those airports that already have implemented EMS, it is important to figure out whether or not their EMS is effective in addressing environmental issues. However, it is very hard to assess the new system's effectiveness because it is difficult to determine exactly how, or what aspects of, the system help airports mitigate impacts on the environment. Airports could benefit greatly from knowing what factors can be used to make this judgment. These factors could be used to assess the effectiveness of their EMS in a direct manner and also could identify specific activities and behaviors to improve on in the future. For those airports that are working towards the implementation of EMS, these factors if known could provide

guidance about what activities or behaviors to concentrate on to ensure their EMS is effective, or if it is worth making an investment in EMS.

1.2 Purpose of Study

The purpose of this study was to identify factors that can be used to assess the effectiveness of EMS at airports in the United States (U.S.). These factors could be important considerations for airports in the development of EMS and help improve the performance of their EMS in the future.

According to the International Civil Aviation Organization's (ICAO) report on EMS practices in the aviation industry, an EMS is used to provide the methodology and framework to help aviation organizations such as airports, air carriers, manufacturers, and government agencies identify and manage significant environmental operations systemically and cost-effectively (ICAO, 2012). According to Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5050-8 *Environmental Management Systems for Airport Sponsors*, an EMS is defined as "a business management practice that allows an organization to address strategically its' environmental matters based on the "Plan, Do, Check, Act" model" (FAA, 2007, p5). Thus, EMS may help reduce the likelihood of the occurrence environmental issues associated with airport operations and may potentially lead to a reduction in operational expenses related to the mitigation of environmental impacts over time such as pollution prevention, source reduction, and waste minimization. Airport sponsors of large or medium hub airports in the

U.S. can obtain Airport Improvement Program (AIP) funding from FAA to help them develop and implement their EMS.

In this study, I focused on airports listed in the FAA's Operational Evolution Partnership (OEP-35) that have already developed EMS. The effectiveness of EMS was considered from several aspects such as how airports solve environmental issues, improve environmental performance, and reduce costs related to the prevention and mitigation of environmental impacts. The factors related to assessing EMS' effectiveness were the research targets determined through the course of the study. The airports included in this research study are presented in Table 1.

Table 1.1

Airports with Environmental Management System (EMS) in the U.S

Airport Code	Airport Name, City	Year
BOS	Boston - Logan International Airport, Boston	2001
DEN	Denver International Airport, Denver	2004
DFW	Dallas / Fort Worth International Airport, Dallas	2007
FLL	Fort Lauderdale - Hollywood International Airport, Fort Lauderdale	2008
HNL	Daniel K. Inouye International Airport, Honolulu	2006
MIA	Miami International Airport, Miami	2001
PHL	Philadelphia International Airport, Philadelphia	2007
STL	Lambert-St. Louis International Airport, St. Louis	2012

Note. The year denotes the time when EMS was introduced to these airports for the first time.

1.3 Background and Rationale

In July 2017, Westchester County discovered groundwater contamination at Westchester County Airport which was suspected to have been caused by

chemicals used in fire-fighting applications decades ago (McKay, 2018). The airport borders the Kensico Reservoir that provides drinking water to New York City and some Westchester residents who rely on the water from this reservoir to meet their daily needs. The potential contamination of the daily water supply chains was identified as a threat to residents' health and daily activities.

The chemicals detected at Westchester County Airport were perfluorooctane sulfonic acid, known as PFOS, and perfluoroalkyl substances, known as PFAS (McKay, 2018). Stewart International Airport had the same chemical on their State Superfund (SSF) list in 2016. According to the New York Department of Environmental Conservation (DEC), "the SSF program is an enforcement program whose goal is to identify and characterize suspected inactive hazardous waste disposal sites and to ensure that those sites which pose a significant threat to public health or the environment are properly addressed" (DEC, n.d.). Although PFOS was gradually phased out in 2002, it was a key ingredient in firefighting foam used at Stewart Air National Guard Base for emergency response and in training exercises. These chemicals can cause health effect on fetuses during pregnancy or to breastfed infants, it could cause testicular or kidney cancer, liver damage or influence the immune or thyroid system (McKay, 2018).

Water pollution is only one of many potential environmental impacts caused by airport operations; other environmental issues also influence people's

daily life including aircraft noise, air pollution, and, waste and recycling. In light of the consideration of environmental protection and human health, how to reduce the influence of operations on the environment became a hot topic for airports. Therefore, the corresponding regulations and tools such as sustainable management plans, environmental impact statements, and the Next Generation Air Transportation System (NextGen) programs are being introduced at airports in the U.S. Among them, EMS is an important tool being implemented that may assist airport managers solve and manage their environmental issues.

EMS was first used in the 1990s to provide organizations with a proactive, systematic approach to managing the potential environmental consequences of their operations (FAA, 2010). In 1996, the first International Organization for Standardization (ISO) 14001 standards for EMS was published. Along with increasing public awareness of environmental protection, EMS was widely adopted by public and private organizations to help address their environmental responsibilities. On January 24, 2007, President George W. Bush issued Executive Order (EO) 13423, Strengthening Federal Environmental, Energy, and Transportation Management. This executive order required that federal agencies use EMS as the primary method of improving interaction between ongoing agency activities and the environment (FAA, 2010). In order to follow the issuance of this executive order, the Department of Transportation (DOT), FAA and Office of Airports (ARP) published FAA Order 1050.21A policy statement and provided

guidance specifically for airport sponsors in FAA AC 150/5050-8. Following this policy statement, the requirements proposed in Executive Order (EO) 13423 were retained and expanded by Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance which was signed by President Obama on October 5, 2009. In addition to the federal agencies that have implemented EMS mandatorily, many private organizations have implemented EMS voluntarily. Currently, EMS also is a mechanism in building the foundation for integrating environmental protection and energy goals into the core business and operational strategies of NextGen and achieving the environmental protection that allows for sustained aviation growth (FAA, 2010).

Airports in the U.S. are one of the most important types of transportation hubs and service tens of thousands of operations every day. How to grow the airports sustainably is a key issue that every airport considers. EMS as a powerful management tool that has already helped airports address their environmental issues. Several studies have researched how EMS helps organizations achieve their environmental goals and how EMS improves the organization's environmental performance. However, the current research has not addressed how to assess whether the EMS used in organizations is effective or not, especially in airport industry. Therefore, this research study endeavored to identify the factors that the airport managers can consider to judge or assess EMS' effectiveness.

1.4 Definition of Terms

The following list includes the definitions of the key terms and phrases.

1. *Airport Public Image* in this study refers to the positive publicity given to airports by surrounding communities due to their outreach and other efforts to be a good custodian of the environment.
2. *Compliance with Relevant Regulations and Legislation* in this study refers the ability of airports in the U.S. to comply with relevant environmental laws, policies, and regulations set forth by the U.S. Environmental Protection Agency (EPA) and FAA.
3. *Cost Effectiveness* in this study refers the ability of the EMS to result in reduction of amount of time and funds spent on mitigating environmental impacts and to support sustainable development from a financial perspective.
4. *Environmental Management System (EMS)* is a business management practice that allows an organization to address strategically its environmental matters. EMS implementation reflects accepted management principles based on the "Plan, Do, Check, Act," model (Federal Aviation Administration, 2007).
5. *Environmental Performance* is the measurable results of an environmental management system. It is related to an organization's control of its environmental aspects, based on its environmental policy, objectives, and targets (U.S. Department of Energy, 2006).

6. *Marketing opportunities* refers to several strategies that airports can use to improve their services in the future such as innovative air service development, users advocating for the airports' service based on their experiences, social care, and storytelling (Nick, 2013)
7. *Next Generation Air Transportation System (NextGen)* is the FAA-led modernization of our nation's air transportation system and it aim to increase the safety, efficiency, capacity, predictability and resiliency of American aviation (FAA, 2017).
8. *Operational Evolution Partnership (OEP-35)* airports are commercial service airports in the U.S. with significant activity and serve as hubs for airline operations (FAA, 2015).
9. *"Plan, Do, Check, Act,"* model is a repetitive four-stage model for continuous improvement (CI) in business process management and was popularized by Dr. W. Edwards Deming; this model is also known as the Deming cycle (Rouse, 2015).

1.5 Research Question

The research question that guided this study is: What are the factors that are related to assessing the effectiveness of EMS at airports in the U.S.?

1.6 Study Design

The proposed study focused on determining the factors that are related to assessing the effectiveness of EMS at airports in the U.S. A survey research methodology was used for this study in two phases. The first phase of the research

study included a preliminary expert opinion survey of airport managers and other individuals acting in a supervisory role to determine and discuss how EMS help improve environmental performance, and ranked factors that may be related to assessing the effectiveness of EMS. Based on the feedback of these experts, a second survey was constructed and targeted airport employees working in a non-supervisory role and obtain their perceptions of EMS' effectiveness based on these factors. Finally, based on the information collected in the secondary survey, descriptive statistics were used to help analyze the relevant data and then gather conclusions.

1.7 Significance of the Study

This study is significant because the current research has focused more on how EMS helps airports solve and manage environmental issues and become more environmentally friendly. However, there is no research to identify the factors to analyze whether the EMS at airports are effective. Thus, this study added to body of knowledge by identifying factors related to the effectiveness of EMS at airports in the U.S. This study could help airport managers and the FAA assess whether their EMS is effective or not and also provide information about how they can improve the performance of their EMS in the future.

1.8 Study Limitations and Delimitations

Limitations are any circumstances or events that are outside of researchers' control that will limit the generalizability of study's results. Delimitations are the circumstances that researchers impose on the study that further limits the

generalizability of the study's results. The following limitations and delimitations will be considered when conclusions and inferences are made in this study.

Limitations. The limitations of this study are as follows:

1. ***Population***. To data, very few airports in the U.S. have implemented EMS; the targeted population in this research are the airports with EMS listed in the OEP-35. With the continued development of EMS, it will be possible for some other airports in the OEP-35 list decide to develop or implement EMS after this research was started. A study of other airports that are currently not one of OEP-35 that have implemented EMS could get different results.
2. ***Sample size.*** Although getting as large sample size as possible to improve the accuracy of the results is one important process, there was no control over the exact number of participants who took part in this study and returned a complete questionnaire. Due to constraints beyond the researcher's control, the time period over which data was limited which in turn had an effect on the size of the sample collected in the second phase of the study. Studies that have larger sample sizes or different survey return rates could get different results.
3. ***Participants' attitude***. In this study, data collection was the most important part because the results and conclusions are based on the survey's feedback. However, there was no control the attitude of the

participants who took part in the survey. Some of them could have positive attitudes and their answers could be more reliable or biased. In contrast, some participants could have a negative attitude towards taking part in the survey and they may not read the questions or answer the questions truthfully. These types of answers would not be reliable and could influence the conclusions drawn at the end of the study.

Delimitations. The delimitations of this study are as follows:

1. ***Survey instrument***. This study used researcher-constructed survey instruments to collect data in distinct two phases. For ease of reference, the instruments used in the first and second phases of the study are provided in Appendix A and Appendix B, respectively.
2. ***Study period***. This study was restricted to eight OEP-35 airports that had implemented EMS before the year 2019, spanning a time period of 12 years from 2001 through 2012. The years during which EMS was implemented at the individual airports is presented in Table 1.1.
3. ***Sampling sources***. This study choose to sample airport managers and employees from OEP-35 airports with EMS in order to maximize the potential sample size in the second phase of study. The rationale for this delimitation was that these airports would have a relatively large pool of employees to sample from. These airports are identified in Table 1.1.

Chapter 2

Review of Related Literature

2.1 Introduction

This chapter introduces relevant information about the related literature and contains three main sections. The first section is an overview of underlying theory that addresses various theories related to EMS including: Deming's "Plan, Do, Check Act" model (Deming, 1950), Conservation theory (Callicott, 1990), and Bandura's (1989) Reciprocal Causation theory. The second section provides a review of the past research studies related to EMS, environmental performance, and environmental management at airports. The last section provides a summary of the related literature and a discussion of the implications for the proposed study.

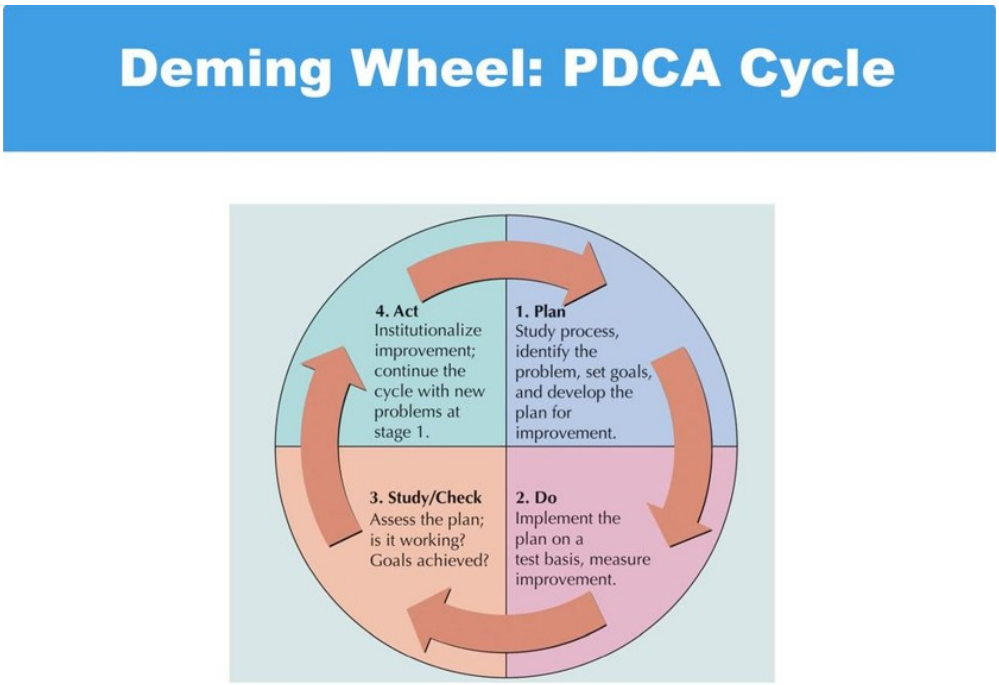
2.2 Overview of Underlying Theory

This study assessed EMS' effectiveness at airports and related the findings to the theory about the EMS itself, the basic principle of protecting environment, and the literature related to designing the survey instrument. The theories outlined below are relevant within the premise of the study and help explain why a survey research methodology was the best choice for this study.

2.2.1 Plan Do Check Act Model. The Plan Do Check Act (PDCA) model, also known as Deming's cycle, is a systematic process for controlling and improving systems and products continually (Deming, 1950). This model includes four steps and the whole process is repeated to meet the requirement of continual improvement. Figure 1 illustrates the process of the PDCA model.

Figure 2.1

Deming Wheel: PDCA Cycle



Source: Operations Management Creating Value along the Supply Chain (Russell & Taylor, 2011)

The first step is Plan and its purpose is to familiarize operators with the current or future processes. In this step, managers are required to identify the current issues and set future goals and then based on the issues and objectives, develop a plan that helps achieve those goals (Russell & Taylor, 2011). When consider using EMS at airports, the first step could be identifying the current environmental issues at the airport and what the airport wants to achieve in the future and create a plan that can help the airport solve this environmental issue. For

example, if an airport manager identifies the airport currently has noise issue and wants to solve this issue in the next one to two years, the manager needs to work with his or her team together to create a plan to identify how to solve it such as noise abatement plan. The plan could propose reducing the number of nighttime flights, installing insulation in residential homes, or building noise barriers on the airport.

The second step is Do, which is implementing the plan and assessing the improvement (Russell & Taylor, 2011). Based on the same example in the previous step, the second step the airport manager should consider is implementing mitigation measures in a noise abatement plan and then measuring the effect. As discussed above, after the manager has developed the plan to reduce noise, the airport would implement the plan at this airport such as constructing noise barriers on the airport and monitoring the noise levels in the surrounding community.

The third step is Check and is used to assess whether the plan is useful and whether the future goal is achieved (Russell & Taylor, 2011). Following the example as above, after implementing the noise abatement plan, the manager could model or measure the reduction in noise levels and impacts to the surrounding communities to determine whether the noise abatement plan is effective.

The last step is Act, which entails institutionalizing the improvement and continuing the cycle with new problems (Russell & Taylor, 2011). For the same noise example described previously, the airport may determine that mitigation

measures outlined in the noise abatement plan helps them achieve their goals, including reducing impacts to the surrounding communities. The airport could decide to implement these measures as a policy procedure to control airport noise and airport manager may then identify a new environmental challenge that the airport wants to achieve in the future.

EMS was based on this PDCA model, so EMS can help in finding environmental issues and provide the effective methods to solve the issue. Therefore, the EMS can control the environmental performance and reduce the risks about causing environmental issues in the future.

2.2.2 Conservation theory. Conservation is the prevention of the wasteful use of a resource and it includes two aspects: 1. Preservation, protection or restoration of the natural environment and of wildlife. 2. Preservation and repair of archeological, historical, and cultural sites and artifacts (Oxford Dictionary, 2018). With respect to EMS, the first aspect of conversation is most relevant and is also known as conservation ethics. Callicott (1990) reviewed the American conservation ethics for 21st century conservation biology in the journal Whither Conservation Biology. Generally, conservation ethics provides ideas about how to use resources to meet the current needs and that will also be a benefit for the future. In addition, Pinchot (1947) defined conservation ethics as “the greatest good of the greatest number for the longest time” (Pinchot, 1947, p326). From my understanding, conservation ethics deals with how to use resources effectively and sustainability to

meet the needs of continual development. Therefore, for the concept of EMS at airports, this theory directs airports to balance development and environment issues. When an airport wants to develop itself, it is almost inevitable that the development could cause some environmental issues. However, it is unwise to only think about development and ignore environment issues because if an airport wants to be sustainable, it is necessary to consider how to use resources reasonably. EMS is an effective tool to check and manage environmental issues to balance the airport development and follows the idea of conservation ethics.

2.2.3 Reciprocal Causation. Reciprocal causation was introduced by Bandura (1989) to refer to the mutual influence between these three variables: environment, person and behavior. As Ormrod (2012) introduced:

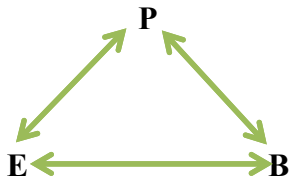
> *"Environment (E). General conditions and immediate stimuli (including reinforcement and punishment) in the outside world. Person (P). An individual's particular physical characteristics (e.g. age, gender, and physical attractiveness), cognitive processes (e.g. attention and expectations), and socially and culturally conferred roles and reputations (e.g. king, student, "popular kid", "geek") Behavior (B). An individual's observable actions and reactions."*

(Ormrod, 2012, p118).

The Figure 2.3 shows the relationship among these three variables.

Figure 2.3

Relationship between environment, person and behavior



Source: Human Learning sixth edition (Ormrod, 2012, P118)

Cooper (2000) used the Reciprocal Causation theory to create a model of safety culture. In this study, a similar model was used to develop surveys about EMS at airports. In this situation, the environment is the airport, the person is employees' opinions and perceptions of EMS, and behavior is a series of environmental actions or achievement.

2.3 Review of Past Research Studies

Past research into EMS has focused more how EMS help organizations become environmentally friendly as well as the connection between EMS and environmental performance. There is a dearth of literature related to EMS at airports because using EMS at airports is a new concept that has not been implemented widely by airports in the U.S. In spite of this limitation, past research still brings invaluable insight to the research question of the study.

2.3.1 Application and Benefits of EMS. After EMS was introduced, several organizations implemented or considered implementing EMS to help them achieve improved environmental performance. Research conducted by Maier and

Vanstone (2005) found that the majority (72.6%) of high impact companies have implemented an environmental management system of at least a 'moderate' standard. They also found that the higher standard EMS could lead to a better environmental performance (Maier &Vanstone, 2005). As they concluded, EMS can benefit a company in a number of ways such as promoting legislative requirements, reducing emissions, identifying the protentional cost savings, and improving public image (Maier &Vanstone, 2005). These findings support the idea that the EMS plays an important role in controlling environmental performance and the future development of a company, and the aforementioned benefits were some of the targeted research factors in this study

Along with EMS development and the high level of achievement in improving environmental performance for more and more organizations in the world, the aviation industry also considered implementing EMS to help control environmental issues caused by aviation activities. The aviation industry anticipated that EMS would be an effective tool in achieving higher environmental performance. ICAO (2012) conducted a survey on EMS practices in the aviation sector, which generally queried the conditions of the use of EMS in aviation systems. Among the 233 responses of organizations including airlines, air navigation service providers (ANSPs), airports, manufacturers and others, 50 percent of responders (117) reflected they had already applied EMS standards or guidelines. Of these organizations, 54 airports reported that they used EMS

standards or guidelines. Moreover, ICAO (2012) also identified areas in which EMS can be helpful to manage and control environmental concerns in aviation system; these included compliance with laws and regulations, state policies, company core values and ethics, corporate image, soil and water protection, waste management, and energy management. The report also introduced basic information about implementing EMS and the benefits and challenges of EMS in aviation systems.

In the U.S., the FAA considered using EMS as an effective tool to balance the growth in the demand for air transportation and aviation's environmental impacts. FAA (2010) published the EMS strategy and framework for NextGen. This report introduced the framework of EMS and an EMS implementation approach for the NextGen program. Furthermore, the U.S. NextGen EMS approach could be improved to allow it to become available for more U.S. aviation organizations. Generally, this report established the foundation for the future development of EMS in the U.S. aviation systems.

Airports also are concerned about managing environmental issues to achieve their environmental goals. In 2013, the Airport Cooperative Research Program (ACRP) published a report about EMS development processes for airport practice. In this report, the authors introduced the basic concept of EMS and conducted surveys of airports in Canada and the U.S. Among the 19 airports that responded, twelve airports had already developed, and one airport was in the

process of developing EMS. This report also reported on important factors that the study airports considered when they decided to implement EMS, which include improved employee understanding of environmental issues and responsibilities, environmental risk reduction, compliance concerns, and improved internal process (ACRP, 2013). ACRP (2013) introduced the basic framework of EMS and the similarities and differences in EMS implementation processes based on 15 EMS components such as policy, goal setting, training, internal communication and external communication for these surveyed airports. The research study concluded that most airports provide management support and available resources for implementing EMS. Almost all of the airports reported environment performance could be improved in several ways including: improving employees' understanding of environmental issues and responsibilities, improving efficiency, and greater management confidence in the system (ACRP, 2013).

2.3.2 Green Airports and Sustainability. Florida Department of Transportation (FDOT) published the Airport Sustainability Guidebook to provide guidance or recommended methods for developing an effective sustainability plan and implementing sustainability initiatives (FDOT, 2017). This guidebook covered a case study with the Miami-Dade Aviation Department (MDAD) on "How MDAD manages reporting challenges and fosters a sustainability mindset throughout the organization." MDAD own and operate the Miami International Airport (MIA). After compiling the record of poor fuel containment practices at MIA, MDAD

decided to pursue International Organization of Standardization (ISO) certification and developed EMS (FDOT, 2017). Currently, MIA Fuel Facility 7 and MIA Civil Environmental Engineering Division 8 are already registered to ISO 14001. The case study noted that it is a challenge to track sustainability and EMS can be used to formalize environmental stewardship practices, identify responsible parties, and track environmental progress.

Carlini (2013) introduced concepts about airports going green and discussed the airports in the U.S. that are implementing sustainability practices. He introduced the concept of sustainability and airport sustainability, and three principles to help airports achieve sustainability including: protecting the environment, maintaining high and stable levels of economic growth, and social progress that recognizes stakeholders' needs (Carlini, 2013). He also introduced the differences between Environmental Assessment (EA), Environmental Impact Statements (EIS) and EMS of which the first two are project specific whereas EMS is a tool to manage and track data. He used several case studies about different types of environmental programs implemented in airports to show how these airports were going green. Among them, he introduced the EMS used at Boston Logan International Airport and showed how the EMS helped the airport achieve its environmental goals by controlling airport operations (Carlini, 2013).

Asinjo (2011) also introduced the concept of environmental management at airports and specifically concentrated on sustainable airport models. She identified

the sustainable airport models are the airports that progressively modify their Environmental Management Programs (EMP) to accommodate changes that aid in mitigating the environmental impacts (Asinjo, 2011). Asinjo (2011) discussed how these sustainable airport models achieve their environmental goals by analyzing their EMS and EMP at these airports. From the analysis, she found that the EMS used in sustainable airport models have the general characteristics necessary for airport environmental management that are to decrease the global and local effects on noise, air quality, water quality, energy, waste, hazardous materials, climate change, habitat, heritage, and wetlands management (Asinjo, 2011). In particular, EMS used in Denver International Airport, Dallas/ Fort Worth International Airport and Athens International Airport showed how EMS helps them manage their airport environmental issues and achieve environmental goals. Some of her recommendations about implementing EMS at airports included: modifying general guidelines for EMS and EMP to meet specific environmental challenges of different airports, allocating environmental management responsibility to current employees, and improving environmental programs through a cooperative effort by involving stakeholders and community participation (Asinjo, 2011).

2.3.3 Measuring Environmental Performance and EMS Effectiveness.

Along the increasing use of EMS at airports, it is reasonable to consider whether or not the implemented EMS is effective. As a new concept, there were no past studies that directly assessed the effectiveness of EMS at airports. However, there

were studies focusing on the use of EMS in other industries that provided some suggestions about how to assess the effectiveness of EMS. In Maier and Vanstone's study, the quality of EMS was measured based on the following indicators: environmental policy, identification of significant impacts, setting of objectives and targets in all key areas, documented structure and procedures, audit program, and internal reporting and management review (Maier & Vanstone, 2005). In addition, Robert Sroufe conducted a study about the Effects of Environmental Management System on Environmental Management Practices and Operations in 2003. The researcher analyzed the largest EMS survey on manufacturing firms in U.S. to test the relationship between EMS and operational performance (Sroufe, 2003). As the results showed, an effective EMS plays an important role in managing, measuring, and improving environmental condition. Furthermore, it is also helpful in environmental requirements compliance and cultural changes.

Environmental performance is one factor that could be used to directly assess the effectiveness of EMS in various industries. The Global Environmental Management Initiative (GEMI) published information about measuring environmental performance in 1998. The organization introduced a survey of tools or metrics for measuring environmental performance, considerations for designing, implementing, evaluating and improving a metric program, trends in environmental performance measurement and several case studies about measuring environmental performance in different organizations (GEMI, 1998). In addition, Maier and

Vanstone (2005) provide some guidance about how to measure environmental performance based on their research. They recommended a company's environmental performance be measured using five key operational direct impacts: climate change, emissions to air, discharges to water, waste, and, water consumption (Maier &Vanstone, 2005). Although none of these metrics were developed directly in the context of the aviation industry, they are very relatable to the direct impacts of airport operations.

Nawrocka and Parker (2009) published a paper about finding the connection between EMS and environmental performance. They discussed the perception of environmental performance and expressed that there are different ways to perceive environmental performance. They concluded it was hard to identify the environmental performance for different organizations using the same standards (Nawrocka & Parker, 2009). The researchers reviewed twenty-three related studies about connecting environmental performance and EMS and found that twenty studies used a survey or interview research methodology, one study used a case study as the research methodology, and two studies used a mix of methods (Nawrocka & Parker, 2009). Their research guided my choice of using a survey research methodology to assess EMS' effectiveness at different airports. Furthermore, a survey research methodology provided the opportunity to concentrate on different airports' situations and goals.

Ostrom, Wilhelmsen and Kaplan's research (1993) and Jin and Chen's research (2013) are good examples of survey research. Both of these studies researched safety culture using survey research methodologies. Ostrom, Wilhelmsen and Kaplan (1993) assessed safety culture which posed similar difficulties as with assessing environmental performance. They used descriptive statistics which included mean, median, percent nonrespondents, and frequencies of response to display the results of the survey used to determine perceptions of safety culture (Ostrom, Wilhelmsen, & B., 1993). Jin and Chen (2013) researched safety culture and concentrated on the interrelationship between environment, behavior, and person. They designed three levels of surveys, which were questionnaires for executives, management, and workers (Jin & Chen, 2013). These aforementioned notions about how to develop surveys also provided guidance in the development of the surveys at two separate levels: airport management and airport employees.

2.4 Summary and Study Implications

As discussed above, several past research studies have considered EMS and EMS at airports providing the background to this study. These studies indicate that the future development of EMS in the global aviation system, especially at airports, will be most valuable. ICAO (2012) and FAA (2010) discussed EMS development in aviation system from a global and national viewpoint. ACRP (2013) reported on the current status of EMS at airports and EMS implementation process at airports. FDOT (2017), Carlini (2013), and Asinjo (2011) discussed EMS implementation in

several U.S. airports through case studies and showed how EMS provides a balance between the development of airports and environmental issues at these airports. These research studies also confirmed EMS's role in controlling environment issues at airports and introduced the process of implementing EMS. Sroufe (2003) and Maier and Vanstone (2005) brought about the general idea about how to qualify the quality of EMS and identified assessment factors relevant to other non-aviation industries. Nawrocka and Parker (2009) introduced the difficulties of measuring environmental performance and their findings support the use of a survey research methodology in measuring environmental performance. Finally, Ostrom, Wilhelmsen and Kapian (1993), Jin and Chen (2013), and GEMI (1998) provide several examples of survey research and questionnaires that helped guide the research methodology and data analysis in this study.

Although there are several studies about EMS at airports, there are still some gaps in the research conducted. ACRP (2013) introduced the current status of EMS at airports and considerations for the implementation of EMS, however, the study did not address EMS' effectiveness at airports. Similarly, Carlini (2013) and Asinjo (2011) concentrated on determining that EMS was helpful and useful in improving environmental performance at airports but did not address the effectiveness of the system. Sroufe (2003) and Maier and Vanstone (2005) explored ways in which the effectiveness of EMS could be assessed, however, this was not specifically related to, or direct at the use of EMS in the aviation industry.

GEMI (1998) introduced several survey research examples concerning environmental performance, however, they also were not directly related to the aviation industry. Moreover, environmental performance is outcome based and not the sole consideration for assessing EMS' effectiveness, which also deals with how well the system is working a whole. As there have been no prior studies related to assessing the effectiveness of EMS at airports, this research study is valuable because it can fill the gap in the body of knowledge. In addition, it is useful for airport managers to understand whether or not the EMS implemented at their airports are effective. This research study also could provide guidance for airports that are planning to use EMS in the future by providing information about the factors that are related to establishing an effective EMS.

Chapter 3

Methodology

3.1 Introduction

This chapter is organized in main four sections as follows: population and sample, instrumentation, procedures, and threats to internal validity. The population and sample section introduces the details of the population and sample of this study; the instrumentation section explains how the survey instruments were constructed; the procedures section presents the independent and dependent variables, and how the study was implemented; and lastly the threats to the validity of the study are identified.

3.2 Population and Sample

3.2.1 Population. The target population of the study consists of all U.S. airports that developed EMS prior to the year 2019. The accessible population consists of eight airports with EMS that are included in the FAA's OEP-35 list. These airports are Boston -Logan International Airport (BOS), Denver International Airport (DEN), Dallas/ Fort Worth International Airport (DFW), Fort Lauderdale-Hollywood International Airport (FLL), Daniel K. Inouye International Airport (HNL), Miami International Airport (MIA), Philadelphia International Airport (PHL), and Lambert-St. Louis International Airport (STL). As the OEP-35 airports serve major metropolitan areas and have significant activity (FAA, 2015), it is conceivable that these eight airports' conditions are representative of most of airports that already implemented EMS in the U.S.

BOS is the primary domestic and international airport in New England and plays a key role in the metropolitan Boston and New England passenger and freight transportation networks (Massachusetts Port Authority, 2016). The airport covers 2,384 acres land area and has six runways and four passenger terminals. It is the 17th busiest airport in the U.S and the EMS in BOS is independently certificated to the ISO 14001 2004 international standard. The 2015 environmental data report states that the most recent ISO 14001 EMS certification audit took place in June 2014 and was valid through July 2017 (Massachusetts Port Authority, 2016).

DEN is an international airport in Denver, Colorado and is the largest airport in the U.S. with a land area of 33,500 acres (Schilling, 2013). DEN was the first international airport in the U.S. to have the EMS certified to the ISO 14001 international standards (DEN, 2018). Furthermore, as stated in the DEN 2012 annual report, DEN is the only U.S. international airport that has designed and implemented an ISO 14001 certified EMS that encompasses the entire airport (DEN, 2012). The EMS in DEN helps identify and mitigate all potential impacts to the environment from airport operations (DEN, 2018).

DFW is located in north central Texas between the cities of Dallas and Fort Worth and covers more than 19,072 acres. DFW has seven runways and five terminals in total. In 2007, DFW issued an EMS administrative policy and procedure with the aim to achieve leadership in its environmental responsibility and stewardship programs in the air transportation industry and to establish a

sustainable, beyond compliance standard of environmental excellence at the airport (DFW, 2007). The EMS in DFW provides a user-friendly framework from which to distinguish the environmental risk aspects of each department's operations (FAA, 2013).

FLL is located in Broward County, Florida and encompasses 1,380 acres. The airport has two runways and four terminal buildings. As reported by the Airport Council International (ACI) – North America, FLL began to implement GreenPath® in 2008, which is a proprietary EMS that was implemented by Delaware North Companies Travel Hospitality Services. The policies and procedures of GreenPath have been developed to conform to the ISO 14001 standards (ACI, 2018).

HNL is the principal aviation gateway of the city and county of Honolulu in the state of Hawaii and identified as one of the busiest airports in the U.S. HNL covers 4,220 acres and has four major runways and two designated offshore runways. On January 30, 2006, the State of Hawaii Department of Transportation (DOT) entered a consent decree between the U.S. Environmental Protection Agency (EPA) and the State of Hawaii Department of Health (DOH). This decree required DOT develop and implement a compliance-focused EMS for the airport, harbors, and highway divisions. The scope of the EMS includes all processes, operations, maintenance activities, contractors and persons working on behalf of the DOT doing the official business within eleven airports' division maintenance

baseyard fence line including Daniel K. Inouye International Airport, DOT maintenance baseyard (DOT, 2013).

MIA is the primary airport serving the Miami area and covers 3,300 acres. The airport has four runways and three terminal buildings. MIA is operated by Miami-Dade Aviation Department (MDAD) which is committed to conducting its operations in an environmentally responsible manner pursuant to MIA environmental policy (MIA, 2018). MIA aims to provide efficient aviation service and also achieve the highest environmental quality for air, soil, and water. In order to achieve this goal, MIA is registered for the ISO 14001 in the following airport units: fuel facility, civil environmental engineering, facilities maintenance and engineering, and commodities management divisions (MIA, 2018).

PHL is a major airport in Philadelphia, Pennsylvania and is the largest airport in the Delaware Valley region and in the state. PHL covers 2,302 acres and has four runways and seven terminal buildings. PHL is committed to operating its facilities in an environmentally responsible manner and conserve the unique existing resources of the airport (PHL, 2018). In order to achieve this objective, PHL developed a compliance-focused EMS based on the Environmental Policy Statement (EPS) that helps track regulatory compliance issues and airport activities pertaining to energy, habitat, solid waste, spills, air emissions, noise and regulated waste (PHL, 2018).

STL is the largest and busiest airport in Missouri and encompasses 2,800 acres. Four runways and two terminals serve STL. In order to achieve their sustainability goals, STL started to formalize an EMS approach to develop environmental programs, initiatives, and policy (STL, 2013). In 2009, STL received an EMS grant from FAA and then in 2012, STL received the EMS ISO 14001 self-certified status (STL, 2013). With the development of EMS, the airport sustainability was improved and during the years 2012 and 2013, STL received an award of "Merit-Greatest Gain Owner" category in the St. Louis Regional Chamber's Green Business Challenge (STL, 2013).

3.2.2 Sample. The samples for both phases of this study were obtained on a voluntary basis. The sampling strategy was convenience sampling which involves selecting participants because they are willing and available to be studied. In the first phase of the study, management personnel at DEN, HNL, and PHL participated in a researcher-constructed high level survey, in which they provided feedback about what general factors could be used to assess the effectiveness of EMS and how to rank these factors in terms of relevance. The average survey response rate is about 33 percent (Lindemann, 2018), and the survey response rate in the first phase survey was 37.5 percent which is higher than the average. Therefore, the first phase survey had an acceptable response rate. During the second phase of the study, 10 airport employees at DEN, HNL, PHL and STL airport participated in a more refined researcher-constructed survey, in which they

provided their opinions of more specific and detailed fundamental elements of the previously ranked factors. Throughout the data collection phase of the study, multiple reminders encouraging participation were sent to the airport employees in order to maximize the response rates.

3.3 Instrumentation

This study used a survey instrument to help collect data in two separate parts. The first phase of the survey was sent to the targeted airport managers through email and included seven questions designed to elicit their opinions about the implementation of EMS, their airport's environmental performance achievements after implementing EMS, and their opinions about what factors would be important assessing the effectiveness of EMS at their airports. These managers were provided with a suggested list of factors related to assessing the effectiveness of EMS which was partially informed by the findings of Maier and Vanstone (2005) and adapted to better reflect the airport environment. In addition to this list, the survey included open-end questions that were designed to elicit the ideas of these managers about other any other factors they thought should be included within the list and their rank. For ease of reference a copy of the first phase survey instrument is provided in Appendix A.

The second phase of the survey targeted airport employees in the sample airports and was hosted online using SurveyMonkey. This survey was designed considering the feedback from the first phase survey about factors that are related to assessing the effectiveness of EMS, the researcher's understanding of commonly

known airport operational impacts to the environment, as well as, information provided in environmental reports issued by the sample airports. The survey was divided into two sections; the first to gather airport employee opinions about the factors that can be used to assess the effectiveness of EMS and the second to gather background information.

In the first section, airport employee opinions were recorded on a Likert-type scale of 1-5, given as 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, and 5-Strongly Agree. The participants were asked to provide their opinions about specific statements that were related four main factors identified in the first phase of the study: environmental performance, cost effectiveness, compliance with relevant regulations and legislation, and improve airport public image and bring market opportunities. The environmental performance subsection contained nine statements about EMS' potential for reducing of air emissions, solid waste, fuel spills, and the risk of encountering environmental issues or related issues. The cost effectiveness subsection contained five statements that were related to EMS' potential for improving airport environment performance in a sustainable manner and achieving financial sustainability. The compliance with relevant regulations and legislation section contained four questions related to EMS' potential for providing guidance for airport activities and improving employee awareness of environmental issues. The last subsection, improve airport public image and bring market opportunities, also contained four questions which concentrated on EMS'

potential for helping airports get more development opportunities in the future. All of the twenty two questions were provided to the participants in a random order to ensure the integrity of the survey being hosted online.

The second section of the survey addressed the employment's background information in five open-ended questions to identify the employee's working experience, working department, the awareness of the EMS at their airports, and their opinions about which factors can be used to assess the effectiveness of EMS. The feedback from this section was used to validate the survey information was provided by individuals qualified to do so. For ease of reference a copy of the first phase survey instrument is provided in Appendix B.

3.4 Procedures

3.4.1 Research methodology. This study used a survey research methodology to conduct the required research. This research methodology was appropriate because it can help researchers identify the participants' opinions, attitudes or knowledge clearly. In this way, this methodology helped collect the participants' opinions about EMS' effectiveness at their airports directly and therefore the results are more reliable. All the data were collected by the surveys sent to the sample airports' employees and the survey results were used to answer the research question in this study.

3.4.2 Human subject research. I followed the ethical principles of human subject research because the study involved human subjects. A "Student Application for Research Involving Human Subjects" form was submitted to

Florida Institute of Technology's Institutional Review Boards (IRB) prior to commencing the study. The IRB approved the study on September 13, 2018 and a copy of the approval letter is provided in the Appendix C of this study.

3.4.3 Description of independent and dependent variables. The purpose of this research was to determine factors that are related to assessing the effectiveness of EMS at airports in the U.S. Thus, the current study sought to determine variables by which a dependent variable such as the effectiveness of EMS could be measured at airports in the U.S. No measurement of the dependent variable was made in this study, rather, the study identified and sought confirmation of related variables in a two phase survey process. The independent variables are the factors that can be used to assess the effectiveness of EMS at the airports and these factors were determined to generally include environmental performance, cost effectiveness, compliance with relevant regulations and legislation, and improve airport public image and bring market opportunities. These were based on my preliminary research and the feedback from airport management in the first phase of the study. The second phase of the study verified these general factors in greater detail by surveying airport employees and determining their opinions which were measured on a Likert-type scale. The higher the score obtained for any factor implied that the factor was more critical to the assessment of the effectiveness of EMS at the airports as discussed in Chapter 4, Results of the Study.

3.4.4 Study implementation. As described in the instrumentation section, this study used a two phase survey to help collect data. To ensure face and content validity of the first phase survey, the survey was sent to my committee for review prior to data collection. Based on their expertise in research, airport sustainability, and environmental engineering, as well as their experience working the airport industry, the committee provided suggestions on how to improve the first phase survey questions. Following this review and correction process, the first phase survey was sent to all of the eight airports with EMS by email. The response period was limited to three weeks in order to provide adequate time for completion of the second phase of the study. Three airports responded within this time period with their ranking of the primary factors that they considered to be related to assessing the effectiveness of EMS at airports. During the waiting period, several follow up were sent to the airport managers through email in order to maximize the response rate. These correspondence efforts are included in Appendix D.

Upon completion of the first phase of the study, the second phase survey was developed. The content validity of this phase of the survey also was confirmed via committee, through airport management feedback provided during the first phase of the study and airport environmental reports. Following the second review and correction process, the second phase online survey was created on the SurveyMonkey website and the link to the survey was sent to the targeted airport managers for dissemination to their airport employees. As such, the employees

received the invitation to participate through their manager's email and participated voluntarily. During a six week period, email reminders were sent periodically to the airport managers asking them to kindly remind their employees to participate in the survey. Due to time limitations, the online survey was closed out after a two month waiting period. For confidentiality and anonymity, the survey did not include self-identifying questions and the participants' names were not collected or identified. The online data was password protected only could be accessed by my advisor and myself. Upon the completion of the data collection phase of the study, these data were deleted from the website.

3.4.5 Cronbach's alpha. Before analyzing the data collected, Cronbach's alpha was calculated and used to check the second phase survey's internal consistency and reliability. Generally, if the Cronbach's alpha is higher than 0.8, it means the instrument used in the study has really high reliability (Cohen et al., 2003). If the Cronbach's alpha is higher than 0.5, the instrument also can be acceptable to use to collect data in specific circumstances (Worthen et al., 1999). Cronbach's alpha was calculated for the online survey as all whole, and also for each of the four individual subsections as presented in Table 3.1. The Cronbach's alpha calculated for the second phase survey is approximately or higher than 0.8 which implies the instrument created for collecting the data was very reliable.

Table 3.1

Cronbach's Alpha

Section	*Cronbach's Alpha*	*SD*
Survey	0.96	0.42
Environmental Performance	0.91	0.43
Cost Effectiveness	0.79	0.23
Compliance with Relevant Regulations and Legislation	0.89	0.30
Improve Airport Public Image and Bring Market Opportunities	0.89	0.38

Note. The survey included 22 statements in total, 9 statements in the environmental performance section, 5 statements in the cost effectiveness section, 4 statements in the compliance with relevant regulations and legislation section, and 4 statements in the improve airport public image and bring market opportunities section.

3.5 Threats to Internal Validity

"Internal validity refers to the inferences about whether the changes observed in a dependent variable are, in fact, caused by the independent variable(s) in a particular research study rather than by some extraneous factors." (Ary, Jacobs, & Sorensen, 2010, p272) Ary, Jacobs & Sorensen introduced eleven threats to internal validity include: history, maturation, testing, instrumentation, statistical regression, selection bias, experimental mortality (attrition), selection-maturation interaction, experimenter effect, subject effects, and diffusion (Ary, Jacobs, & Sorensen, 2010). In this study, four threats were considered relevant and include: mortality, location, instrumentation, and selection bias. The following discussion provides more detail about these threats and how they are related to this study.

3.5.1 Mortality. Normally mortality occurs when a differential loss of participants from the groups affects the dependent variable (Ary, Jacobs, &

Sorensen, 2010). The differential loss could cause the different outputs for studies because if one type of specific participants is lost, the proportion of other participants' effect on final results will increase. Three participants in the study did not finish the second section of the phase two survey about the background information. The lack of this background information did not affect the ability to answer the research question. However, not answering the background could either be an unwillingness to share information perceived to limit anonymity or it could be due to the attitude of these participants toward the survey. A negative attitude to the survey could influence the opinions of the participants about the factors being studied.

3.5.2 Location. The location threat is identified as when a change in the location of the study take places and could influence the final result (Ary, Jacobs, & Sorensen, 2010). In this study, the second phase survey was available online and all of the airport employees could participate in the study in different locations. For example, some participants may have completed the survey when they were in their office but some of them may have completed the survey when they were on trip or at home. The different locations could influence participants' attitude about this survey. The participants who took part in the survey when they were in office could treat this survey as part of their job and they could be more professional than those participants who took part in the survey when they were on trip or at home. On the other hand, some of them could be more relaxed when they were at home and had

more positive feelings towards the survey than those who participated in their offices. These changes or differences could affect the validity of the inferences drawn about the targeted research factors.

3.5.3 Instrumentation. The instrumentation threat refers to any unreliability or change in the measuring instrument that could affect results (Ary, Jacobs, & Sorensen, 2010). Open-ended and online survey questions were used to collect data as there had been no other past studies on this topic. In order to ensure content validity and reliability of the instrument, all questions were sent to committee to review before sent to the participants.

3.5.4 Selection Bias. The selection bias threat refers to the bias introduced by the selection of participants that can cause different results for the survey (Ary, Jacobs, & Sorensen, 2010). As the survey was completed on a voluntarily basis, there were no control over the participants. These participants could have all been from same department or have same background knowledge about EMS. In this study, some participants worked for the regulating agency rather than for airport directly. It was possible for their views on how the EMS worked at airports to be different from those directly worked for airport. Additionally, this selection bias threat may be compounded by the limited sample size collected in the second phase of the study.

Chapter 4

Results of the Study

4.1 Introduction

Chapter 4 describes the results of this study and is presented in four sections: Phase I Survey Results, Phase II Survey Results, Comparative Analysis, and Critical Assessment Factors. The descriptive statistics were used primarily to report the results of the study and were supplemented with corresponding tables and bar graphs. The Phase I Survey Results section reports on the ranking of those general factors that are related to assessing the effectiveness of EMS at airports with corresponding tables and figures. The Phase II Survey Results contains an item analysis of the phase two survey, an analysis of the research factors, and a content analysis of background information and anecdotal information. In this section, the number of participants, average score, and the standard deviation, and range were used to report the details of the response of the survey questions with corresponding tables and figures. The Comparative Analysis section compared the first phase survey results and second phase survey results. Through the analysis, the attitude of the rank of factors were compared and presented. Lastly, the most informative results of this study were identified and reported as Critical Assessment Factors.

4.2 Phase I Survey Results

As described in the methodology, the first phase survey was used to collect airport management's opinion of the suitability of the factors related to assessing

the effectiveness of EMS at airports and their rank, that is, what they considered the most important factors. In this survey, airport managers were required to rank those factors by scoring. The overall score of each factor was calculated by summing the scores provided by each airport manager for each factor. These scores were converted to ranks using the methodology introduced by Wallnau and Gravetter (Wallnau & Gravetter, 1996). The items scored lower were given the higher rank. Because the factors improve airports' public image and increase the market opportunities are related, these two factors were combined together in the final analysis. The score used to rank the combined factor was the mean of the separate scores. **Table 4.1** shows the details of the results of the first phase survey.

Table 4.1

1st Phase Survey Rank of the Factors related to Assessing Effectiveness of EMS

Assessment Factor	***Score***	***Rank***
Improves Environmental Performance	5	2
Cost Effectiveness	10	3
Compliance with Relevant Regulations and Legislation	4	1
Improves Airport Public Image and Bring Market Opportunities*	13	4

Note. Starred statement (*) is the combination of the improve airport public image factor and the increase market opportunities factor. The score for improve airport public image factor is 12 and the score of increase market opportunities factor is 14. The score in this table (13) is the mean of 12 and 14.

As shown in the table, airport managers considered compliance with relevant regulations and legislation the most important factor that can be used to assess the effectiveness of EMS at airports. The second most important factor was improves environmental performance, the third factor was cost effectiveness, and

the fourth factor was improves airport public image and bring market opportunities. These results are discussed in further detail in Chapter 5 of the study.

4.3 Phase II Survey Results

4.3.1 Item Analysis. The number of participants, mean score, and standard deviation were determined and were used to present the survey results of each section in the second phase survey. These details are shown in the following tables and figures.

Table 4.2

Improves Environmental Performance Section Response

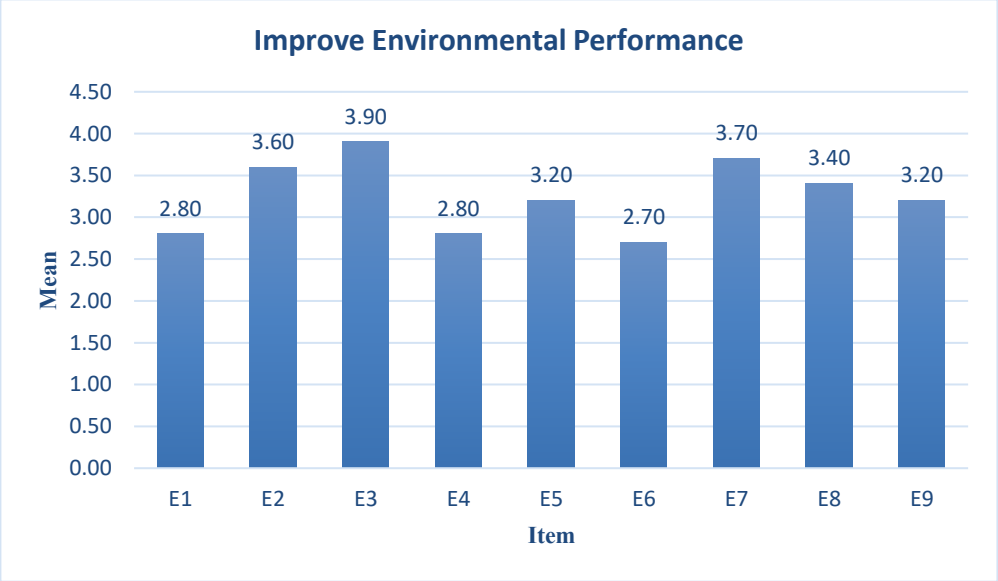
Item[a]	Statement	*N*	*M*	*SD*
E1	EMS is effective in reducing air emissions from vehicular traffic on the airfield by improving ground transportation circulation and/or using environmentally friendly vehicles such as electric vehicles.	10	2.80	1.03
E2	EMS is effective for managing stormwater discharge.	10	3.60	1.17
E3	EMS is effective in reducing and/or disposing of solid waste generated by airport operations.	10	3.90	0.88
E4	EMS is effective in reducing the consumption of potable water and managing its reuse.	10	2.80	0.92
E5	EMS is effective in reducing energy consumption through installing high-efficiency equipment, working on energy management program or energy conservation measures.	10	3.20	1.03
E6*	EMS is not effective in controlling wildlife on the airport.	10	3.30	0.82
E7*	EMS is not effective in mitigating environmental issues in the future.	10	2.30	0.95
E8*	EMS is not effective in reducing fuel spills and handling hazardous materials	10	2.60	0.97
E9*	EMS is not effective in inspecting tenants, construction sites, and stormwater outfall.	10	2.80	1.23

Note. The environmental performance survey section contained nine items which were constructed by the researcher and measured on a Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

[a]Starred items (*) are negatively worded and the reported corresponding *M* and *SD* are the raw data prior to reverse scoring. After item E6, E7, E8, and E9 are reverse scored, the overall mean of this section is 3.26, which means the participants had a relatively positive perceptions of the importance of this factor. *N* = number of participants.

Figure 4.1

Improves Environmental Performance Section Response



Note. E1= EMS is effective in reducing air emissions from vehicular traffic on the airfield by improving ground transportation circulation and/or using environmentally friendly vehicles such as electric vehicles. E2= EMS is effective for managing stormwater discharge. E3= EMS is effective in reducing and/or disposing of solid waste generated by airport operations. E4= EMS is effective in reducing the consumption of potable water and managing its reuse. E5= EMS is effective in reducing energy consumption through installing high-efficiency equipment, working on energy management program or energy conservation measures. E6= EMS is not effective in controlling wildlife on the airport. E7= EMS is not effective in mitigating environmental issues in the future. E8= EMS is not effective in reducing fuel spills and handling hazardous materials. E9= EMS is not effective in inspecting tenants, construction sites, and stormwater outfall. The scores for negatively worded items, E6, E7, E8, E9 are reversed in this figure. The original scores were shown in Table 4.2.

Table 4.3

Cost Effectiveness Section Response

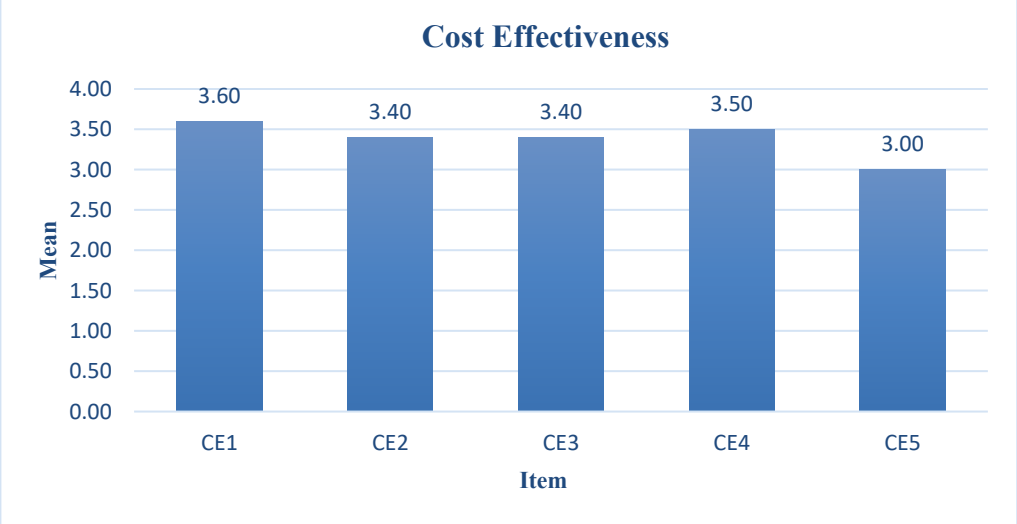
Item[a]	Statement	*N*	*M*	*SD*
CE1	EMS helps the airport to reduce the cost of handling environmental issues.	10	3.60	0.97
CE2	EMS helps reduce the time it takes to resolve environmental issues.	10	3.40	0.84
CE3*	EMS does not help the airport save money in the long run.	10	2.60	0.97
CE4*	EMS does not help the airport develop in a sustainable manner.	10	2.50	1.08
CE5	EMS helps the airport in achieving financial sustainability.	10	3.00	1.15

Note. The cost effectiveness survey section contained five items which were constructed by the researcher and measured on a Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

[a]Starred items (*) are negatively worded and the reported corresponding *M* and *SD* are the raw data prior to reverse scoring. After items CE3 and CE4 are reverse scored, the overall mean of this section is 3.38, which means the participants had relatively positive perceptions of the importance of this factor. *N* = number of participants.

Figure 4.2

Cost Effectiveness Section Response



Note. CE1= EMS helps the airport to reduce the cost of handling environmental issues. CE2= EMS helps reduce the time it takes to resolve environmental issues. CE3= EMS does not help the airport save money in the long run. CE4= EMS does not help the airport develop in a sustainable manner. CE5= EMS helps the airport in

achieving financial sustainability. The scores for negatively worded items, CE3, and CE4 are reversed scores in this figure. The original scores were shown in Table 4.3

Table 4.4

Compliance with Relevant Regulations and Legislation Section Response

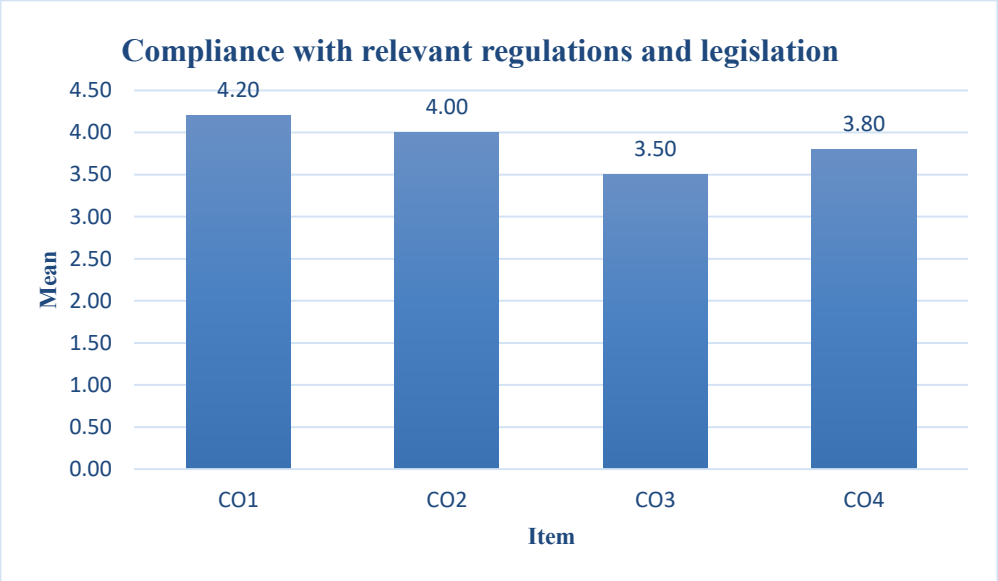
Item[a]	Statement	*N*	*M*	*SD*
CO1	EMS helps guide the airport decision making processes related to the environment and development.	10	4.20	0.63
CO2	EMS provides guidance for airport activities.	10	4.00	0.82
CO3*	EMS does not help the airport meet the Federal Aviation Administration's requirements for environmental issues.	10	2.50	1.27
CO4*	EMS does not improve employees' awareness of environmental issues and environmental protection.	10	2.20	1.03

Note. The compliance with relevant regulations and legislation survey section contained four items which were constructed by the researcher and measured on a Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

[a]Starred items (*) are negatively worded and the reported corresponding *M* and *SD* are the raw data prior to reverse scoring. After items CO3 and CO4 are reverse scored, the overall mean of this section is 3.88, which means the participants had relatively high level perceptions of the importance of this factor. *N* = number of participants.

Figure 4.3

Compliance with Relevant Regulations and Legislation Section Response



Note. CO1= EMS helps guide the airport decision making processes related to the environment and development. CO2= EMS provides guidance for airport activities. CO3= EMS does not help the airport meet the Federal Aviation Administration's requirements for environmental issues. CO4= EMS does not improve employees' awareness of environmental issues and environmental protection. The scores for negatively worded items, CO3, and CO4 are reversed in this figure. The original scores were shown in Table 4.4.

Table 4.5

Improve Airport Public Image and Bring Market Opportunities Section Response

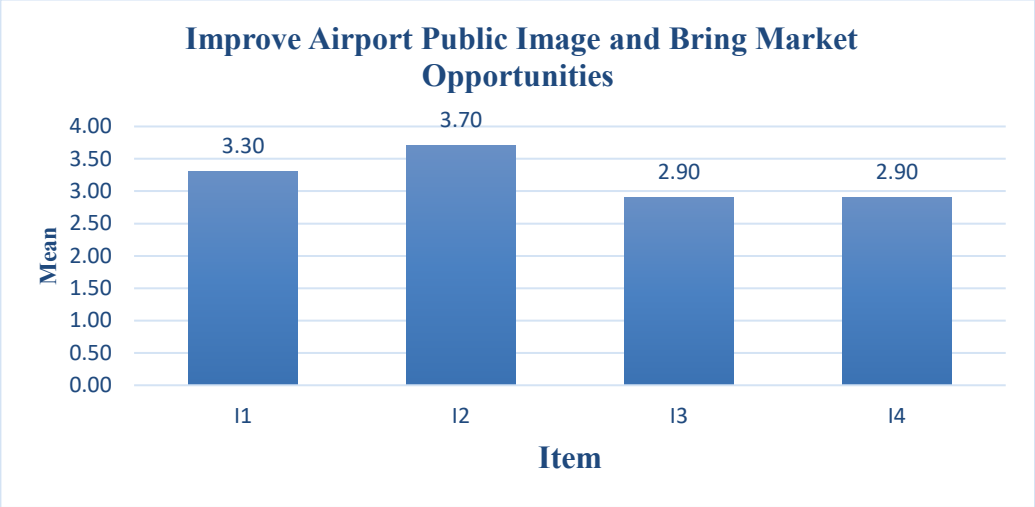
Item[a]	Statement	*N*	*M*	*SD*
I1	EMS helps in building a good relationship between the airport and surrounding community.	10	3.30	1.06
I2*	EMS does not help the airport earn awards and recognition for being a good custodian of the environment.	10	2.30	1.06
I3	EMS brings more opportunity for the airport to be exposed to the public through various media.	10	2.90	0.88
I4	EMS attracts more attention from the investors and brings more opportunities for airport sustainable development in the future.	10	2.90	0.57

Note. The improve airport public image and bring market opportunities survey section contained four items which were constructed by the researcher and measured on a Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

[a]Starred items (*) are negatively worded and the reported corresponding *M* and *SD* are the raw data prior to reverse scoring. After item I2 is reverse scored, the overall mean of this section is 3.20, which means the participants generally had a relatively positive perceptions of this factor. *N* = number of participants.

Figure 4.4

Improve Airport Public Image and Bring Market Opportunities Section Response



Note. I1= EMS helps in building a good relationship between the airport and surrounding community. I2= EMS does not help the airport earn awards and recognition for being a good custodian of the environment. I3= EMS brings more opportunity for the airport to be exposed to the public through various media. I4= EMS attracts more attention from the investors and brings more opportunities for airport sustainable development in the future. The scores for negatively worded item I2 is reversed in this figure. The original score was shown in Table 4.5

Tables 4.2 through 4.5 and Figures 4.1 through 4.4 reflect the participants' perceptions of the importance of environmental performance, cost effectiveness, compliance with relevant regulations and legislation, and improve public image and bring market opportunities factors in assessing the effectiveness of EMS. Moreover, based on these tables and figures participants were found to have the most positive perceptions of several items including E2, E3, E7, CE1, CO1, CO2, CO4 and I2, which means that managing storm water discharge, reducing and/or

disposing of solid waste, mitigating environmental issues in the future, reduce the cost of handling environmental issues, guide the airport decision making processes and airport activities, improves employees' awareness of environmental issues and environmental protection, and earn awards and recognition for being a good custodian of the environment could be considered specific factors related to assess the effectiveness of EMS at airports. These items were identified on the basis of having a mean score of 3.5 or higher. For negatively wording items, the derived means from reverse scoring were used. Reverse scores were determined using the formula: six minus the initial score. The rationale for selecting a mean score of 3.5 as the boundary is that any score closer to 4.0 than 3.0 on the Likert scale used can be considered as the participants tending to agree the item could be used to assess the effectiveness of EMS at airports.

4.3.2 Factor Analysis. Table 4.6 and Figure 4.5 present the overall mean scores for each factor studied and Table 4.7 shows possible range scores for the four factors below.

Table 4.6

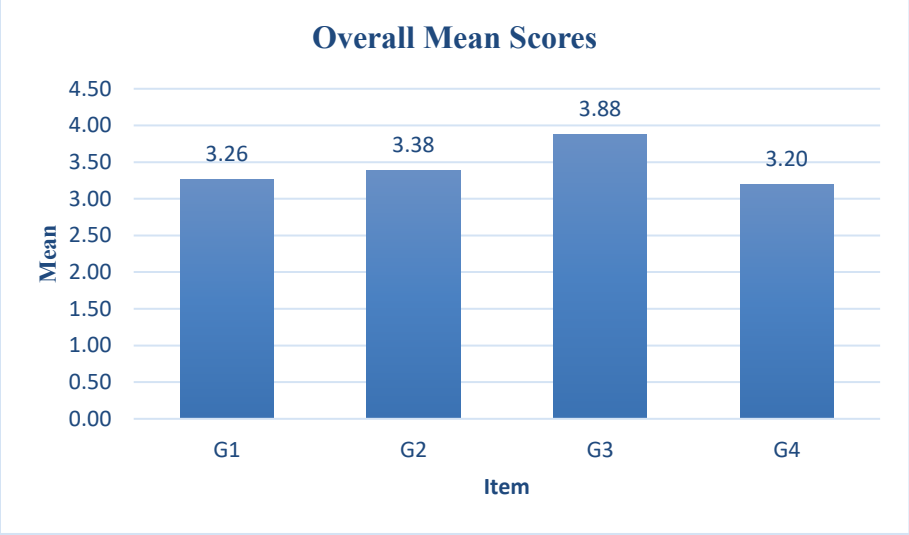
Overall Mean Scores for Factors used in Assessing the Effectiveness of EMS

Item[a]	Assessment Factor	*N*	*M*	*SD*
G1	Improves Environmental Performance	9	3.26	0.43
G2	Cost Effectiveness	5	3.38	0.23
G3	Compliance with relevant regulations and legislation	4	3.88	0.30
G4	Improve Airport Public Image and Bring Market Opportunities	4	3.20	0.38

Note. N = Number of items used to assess the individual factors.

Figure 4.5

Overall Mean Scores



Note. G1 – Improves environmental performance. G2 – Cost effectiveness. G3 – Compliance with regulations and legislation. G4- Improve airport public image and bring market opportunities.

As shown in Table 4.6 and Figure 4.5, the factor compliance with relevant regulations and legislation had the highest mean score, cost effectiveness was ranked second, environmental performance was ranked third, and improve airport public image and bring market opportunities was ranked fourth. All the means of these four factors are higher than 3.0 which means the participants had the relatively positive attitude towards these factors. It also means that the participants somewhat agree these factors could be used to assess the effectiveness of EMS at airports.

Table 4.7

Range, Median, Sum of Mean Scores for Assessment Factors

Assessment Factor	*Range*	*Median*	*Sum of Mean Scores*
Improves Environmental Performance	[9,45]	27	27.30
Cost Effectiveness	[5,25]	15	15.10
Compliance with relevant regulations and legislation	[4,20]	12	12.90
Improve Airport Public Image and Bring Market Opportunities	[4,20]	12	11.40

Note. The range describes the interval of the sum score for each factor. The median describes the middle sum score for each factor, it means average attitude for each factor. The sum of mean scores describes the sum of actual mean from the survey results. Through comparing the position of sum of mean scores and median, we can generalize the actual attitude for each section. If the sum of mean scores is on the right side of median (> median), it means the actual attitude is more positive than average.

As shown in Table 4.7, the sum of mean scores were higher than the median of the range for all of the factors except improve airport public image and bring market opportunities. Similar to the factor analysis, this means the participants' perception of the first three factors were positive, however, their overall perception of the assessment factor improve airport public image and bring market opportunities fell below the median score for this factor. These results will be discussed in further detail in Chapter 5.

4.3.3 Background Information. The majority of the participants in this study worked directly with EMS at their airports. The participants were employees of HNL, DEN, PHL, and STL. They had from 2 to 33 years of working experience in the Environmental and Safety, Environmental Services, Infrastructure Maintenance and Development, Aviation Services and Business Development,

Planning and Environmental Services, and Engineering departments at their respective airports. Generally, most of them were familiar with the EMS and had a general idea about how EMS worked at their airports.

4.3.4 Open-ended Question Information. In addition to the responses provide for each item, the participants also responded to open-ended questions and provided anecdotal information about the EMS at their airports. In summary, EMS was considered a systematic process that identifies environmental risk to airports and implementing EMS definitely benefited their airports. It can help to prioritize these risks and establish means and methods to minimize risk and help reduce the impacts of these to the environment. Additionally, an EMS could help to organize, prioritize and allocate resources to address environmental issues and it can provide a stable starting point for all employees by providing a good understanding of how their work impacts the environment. The participants also posed suggestions for factors that they believed also could be used to assess the effectiveness of EMS at airports which included the following: investment in environmental management staffing and budget, the number of violation notices or fines levied against airports by regulatory agencies, and airport tenant awareness of EMS and knowledge of how their operations impact the environment.

The participants also provided comments about the survey questions such as the researcher should provide additional information on how to manage specific environmental areas because some airports did not use EMS in certain areas

described in the survey questions. For example, some airports do not use EMS on stormwater permit plans or sustainability functions. It is possible that the participants could have provided negative responses to the items that represented areas that their EMS do not address.

4.4 Comparative Analysis

A comparative analysis of the first phase and the second phase survey results was conducted. The results of this analysis are shown in Table 4.8 and Figure 4.7 below.

Table 4.8

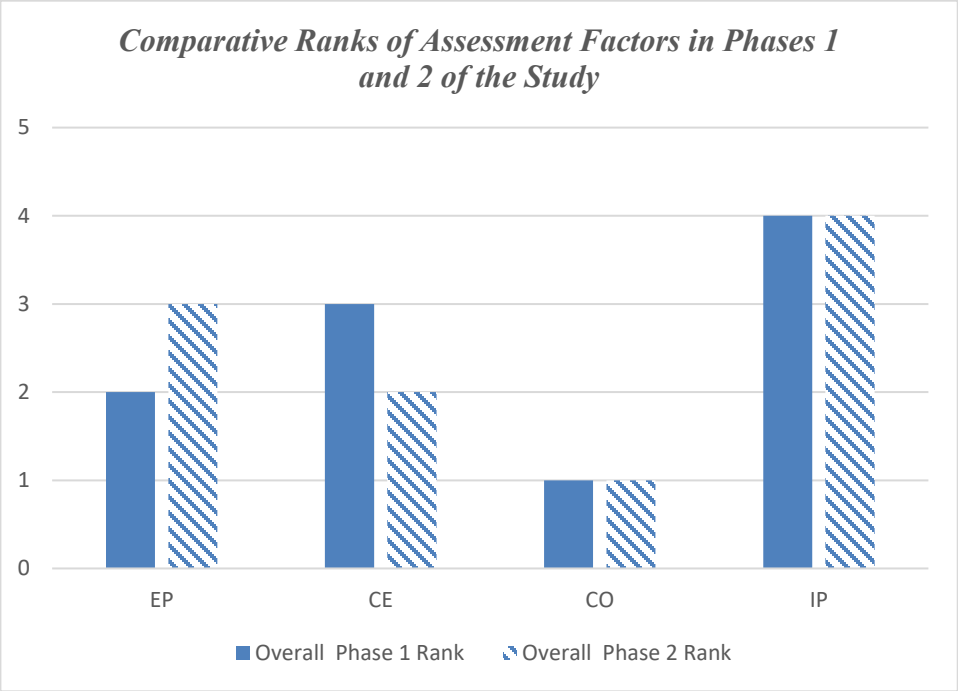
Ranking of Assessment Factors in Phases 1 and 2 of the Study

Assessment Factor	*1st Phase Survey*	*2nd Phase Survey*
Environmental Performance	2	3
Cost Effectiveness	3	2
Compliance with relevant regulations and legislation	1	1
Improve Airport Public Image and Bring Market Opportunities	4	4

Note. The 1st phase survey ranking was calculated by converting the scores of each statement to ranks and the 2nd phase survey ranking was calculated and based on the overall means of each statement.

Figure 4.6

Comparative Ranks of Assessment Factors in Phases 1 and 2 of the Study



Note. EP = Improve Environmental Performance, CE = Cost Effectiveness, CO = Compliance with relevant regulations and legislation, PI = Improve Airport Public Image and Bring Market Opportunities.

As shown in Table 4.8 and Figure 4.6 both groups, airport managers and airport employees, agree that compliance with regulations and legislation was the most important factor and improve airport public image and bring market opportunities was the least important factor that can be used to assess effectiveness of EMS at airports. The ranks for improving environmental performance and cost effectiveness were different, airport managers perceived improve environmental performance as second and cost effectiveness as the third most important factor. However, as shown in the results of the second phase survey, the cost effectiveness

was considered to be the second, and improve environmental performance was considered to be the third most important factor by airport employees.

4.5 Critical Assessment Factors

As stated in Chapter 1, the research question that guided this study was: "What are the factors that are related to assessing the effectiveness of EMS at airports in the U.S.?" In this study, compliance with regulations and legislation was generally considered to be the most important factor in assessing the effectiveness of EMS at airports, ranked the highest in the first phase of the survey and also ranked the highest in the second phase survey with an overall mean score of 3.88 indicating participants tended to agree with all of the items representing this factor. As presented in the Item Analysis, two specific items were critical to its strength: EMS helps guide the airport decision making processes related to the environment and development (M=4.20) and, EMS provides guidance for airport activities (M=4.00). In addition, airport employees tended to agree with the statements: EMS helps the airport meet the FAA's requirements for environmental issues (M=3.50) and, EMS improves employees' awareness of environmental issues and environmental protection (M=3.80).

The other assessment factors researched, improves environmental performance, cost effectiveness, and improves public image and brings market opportunities did not produce the same consensus in the first and second phases of the survey with overall mean scores of 3.26, 3.38, and 3.20 respectively. These scores indicate that airport employees tended to be neutral about these general

factors. However, the Item Analysis revealed that within these sections certain items were perceived to be somewhat critical. Under the environmental performance section airport employees tended to agree with the statements: EMS is effective for managing stormwater discharge (*M*=3.60), EMS is effective in reducing and/or disposing of solid waste generated by airport operations (*M*=3.90), and EMS is effective in mitigating environmental issues in the future (*M*=3.70). Under the cost effectiveness section airport employees tended to agree with the statements: EMS helps the airport to reduce the cost of handling environmental issues (*M*=3.60) and, EMS helps the airport develop in a sustainable manner (*M*=3.50). Lastly, under the section improves public image and brings market opportunities, airport employees tended to agree with the statement: EMS helps the airport earn awards and recognition for being a good custodian of the environment (*M*=3.70). It is notable that any of these specific items could be used to assess the effectiveness of EMS as discussed in Chapter 5.

Chapter 5

Discussion

5.1 Summary of the Study

The purpose of this study was to identify factors related to assessing the effectiveness of EMS at airports. EMS is an important tool for controlling environmental issues and there have been several studies of the use of EMS in different industries. However, EMS is a relatively new system in the aviation industry especially for airports. As such, at the time of this writing very few studies of the use EMS at airports had been conducted. Moreover, the majority of past studies have focused on how EMS can help control environmental issues and improve environmental performance. There was a dearth of literature regarding the issue of how to assess the implemented EMS and determine whether if it was effective or not. For airports, it is useful to identify the factors that can be used to assess the effectiveness of the implemented EMS. These factors can provide ideas for airport managers about how to develop their EMS and which specific areas they should consider when controlling environmental issues. These factors may also be used as, or tied to, performance measures in their strategic plans. Based on the research conducted, the following factors generally were considered important considerations in assessing the effectiveness of EMS: compliance with regulations and legislation, improves environmental performance, cost effectiveness, and improve airport public image and bring market opportunities.

A survey research methodology was used in the study to help collect relevant data in two phases using a researcher-constructed instrument. Content validity of the instrument was confirmed through committee review which resulted in a refinement of the instrument. The first phase of the survey included open ended questions to collect airport managers' expert opinions about EMS implemented at their airports, as well as, their ranking the of the importance of the general factors. Based on the feedback from the first phase of the survey, a second phase survey was developed to collect the opinions of airport employees about specific items grouped under the aforementioned general factors. The second phase survey included 22 statements measured on a Likert-type scale and 5 open-ended questions to elicit background information. The second phase survey was also reviewed by committee and Cronbach's alpha was calculated for each section in order to check the survey's internal consistency and reliability. The Cronbach's alphas were approximately 0.8 or higher, and were good in practice (Cohen et al., 2003) and suitable for making decision about a group (Worthen et al., 1999).

5.2 Summary of the Findings

Descriptive statistics were used to analyze the data collected in this study. In the first phase of the survey, airport managers assigned a score to the general factors related to assessing the effectiveness of EMS as follows: compliance with regulation and legislation was scored 4, improve environmental performance was scored 5, cost effectiveness was scored 10 and, improve the airport public image and bring market opportunities was scored 13. Therefore, in their expert opinion,

the most important factor to assess the effectiveness of EMS at their airport is compliance with regulations and legislation, the second factor is improve environmental performance, the third factor is cost effectiveness, and the fourth factor is improve airport image and bring market opportunities.

In the second phase survey, the mean score and the standard deviation were determined for 22 statements included in the instrument. In addition, the range of possible scores, the median score, and the sum of the mean scores for each section were determined. The range of possible scores for the environmental performance section was 9 to 45, the median 27, and the sum of the mean scores for this section was 27.30. The range of possible scores for the cost effectiveness section was 5 to 25, the median 15, and the sum of the mean scores was 15.10. The range of possible scores for the compliance with relevant regulations and legislation section is was 4 to 20, the median was 12, and the sum of the mean scores was 12.90. The range of possible scores for the improve airport public image and bring market opportunities section was from 4 to 20, the mean was 12, and the sum of the mean scores was11.40. With exception of the factor improve airport public image and bring market opportunities, the sum of the mean scores results were greater than the median of the range. Moreover, the overall mean scores of improves environmental performance, cost effectiveness, compliance with relevant regulations, and improve airport public image and bring market opportunities sections were 3.26, 3.38, 3.88, and 3.20, respectively. Therefore, the ranking of these factors in the second phase

survey was: first compliance with relevant regulations and legislation, second cost effectiveness, third improve environmental performance, and fourth improve public image and bring market opportunities. Although the first and fourth ranked factors were the same, the second and third place ranked factors in this phase were different from the results of the first phase survey. Moreover, the open-ended questions in the second phase of the survey provided insights into other factors that may be important in assessing the effectiveness of EMS at airports. These included: investment in environmental management staffing and budget, the number of violation notices received from regulators, and airport tenants' awareness of EMS and knowledge of how their operations could potentially impact the environment.

The findings of this study are aligned with those of Maier and Vanstone (2005) and Sroufe (2003). Their studies concluded that EMS can benefit organizations by promoting legislative requirements, reducing emissions, identifying the potentional cost savings, improving public image, and improving environmental conditions. The aforementioned items were determined to be specific areas that EMS can play a role on. The current study determined similar factors, previously discussed, could be used to assess the effectiveness of EMS at airports which support the findings of these past studies. Thus, it is reasonable to use a measure of achievement in these specific areas to judge the effectiveness of EMS.

5.3 Conclusions and Inferences

The purpose of this study was to determine the factors related to assessing effectiveness of EMS at airports. Through the research conducted, four main factors were identified namely: compliance with relevant regulations and legislation, improve environmental performance, cost effectiveness, and improve public image and bring market opportunities. In previous studies, researchers focused more on the relationship between environmental performance and EMS, so environmental performance was expected to be the highest ranked factor. However, it was not the highest ranked factor in this study. Of the four main factors, compliance with relevant regulations and legislation was ranked the highest and it can be inferred that, generally, most U.S. airports implement EMS with this main purpose in mind. The reason for why compliance with relevant regulations and legislation was ranked highest in this study could be a confirmation bias related to the purpose for implementing EMS. As mentioned in Chapter 3, the Hawaii DOT developed and implemented a compliance-focused EMS for airports, thus ranking compliance with relevant regulations and legislation the highest. Another reason for this factor ranking the highest could be that EMS was developed based on the PDCA model as noted in Chapter 2. In the PDCA model, "Plan" as the first step is to ensure all the following activities comply with relevant laws and regulations.

While improve environmental performance was ranked second in the first phase of the survey, it was ranked lower than cost effectiveness in the second phase of the study. The reason for this difference could be related to the statements in the

environmental performance section of the instrument. It was noted in the open-ended questions that some of the stated environmental items were not implemented as part of EMS at some of the airports surveyed. Therefore, employees may have been unfamiliar with these items and tended to be neutral about or disagree with the associated statements. Another plausible reason for the lower ranking of environmental performance, is that some participants did not work in airport operations and so, were not familiar with these aspects of environmental performance. On the other hand, the higher ranking of cost effectiveness supports Conservation theory as described in Chapter 2. In the second phase of the survey, airport employees considered managing environmental issues in a cost effective way as being important because it supports the sustainable development of airports in the long-term. Moreover, the results support the conclusions made by Maier and Vanstone (2005) that EMS, when implemented by an organization, also can lead to cost savings, improved environmental performance and a better public image. While we can conclude that aforementioned general factors are potential independent variables for the assessing the effectiveness of EMS, it can also be concluded from the results of the Item Analysis that some factors may be more critical than others.

The Item Analysis revealed that ten specific items could be considered critical factors related to assessing the effectiveness of EMS because the mean scores for these items were 3.5 or higher, meaning the airport employees tended to

agree with the statements. Four critical factors were related to compliance with relevant regulations and legislation: guide the decision-making process, guide airport activities, meet FAA's requirement for environmental issues and improve employees' awareness of environmental issues and environmental protection. Three critical factors were related to environmental performance: manage stormwater discharge, reduce and/or dispose solid waste, and mitigate environmental issues in the future. Two critical factors were related to cost effectiveness: reduce the cost of handling environmental issues, and helps the airport develop in a sustainable manner. One critical factor was related to improve public image and bring market opportunity: earn awards and recognition for being a good custodian of the environment. Therefore, it can be inferred that these specific factors may be targeted as variables for assessing the effectiveness of EMS at airports in the U.S.

As noted in the Comparative Analysis, the first phase and second phase surveys ranked the top and bottom general factors the same but did not rank improve environmental performance and cost effectiveness the same. Environmental performance was ranked second in the first phase but third in the second phase, while the reverse was true for cost effectiveness. As noted before, plausible reason for why the ranking of these factors were different in the two phases of the survey could be that the participants did not provide objective responses to elements of environmental performance that were not implemented at their airports such as reducing vehicular emissions on the airport and water

conservation. Moreover, these results could be skewed due to the relatively small sample size (N=10) obtained in the second phase of the survey.

5.4 Implications

This study identified four general factors related to assessing the effectiveness of EMS at airports and determined ten specific or critical factors that could be used to assess the effectiveness of EMS at airports. These specific factors are important because they can provide the guidance for airport management to distinguish whether the implemented EMS at their airport is effective or not, and thus provide a practical tool for airport operators to engage in continuous improvement. These factors also could be tailored as, or tied to performance measures for purpose of strategic planning.

The implications of these findings for practice include guidance for which areas airports should improve to ensure that their EMS are indeed effective. For those airports considering the implementation of EMS in the future, these findings support those of other studies about the benefits EMS could bring in the future and which specific areas more attention should be paid to in order to control or mitigate environmental issues. Additionally, the study findings support the notion that the implementation of EMS at airports truly plays an important role in controlling environmental issues and improving their environmental performance. Thus, this study promotes the development of EMS in aviation industry especially at airports and identifies future choices for airports making an effort to become more environmentally friendly.

5.5 Recommendations for Future Research and Practice

The following recommendations for future research and practice are based on the results of this study as well as the limitations and delimitations noted in Chapter 1.

The first recommendation is for developing the survey questions. In this study, the survey questions were developed based on the feedback from airport managers and the airports' environmental reports. Although, the second phase survey covered a large number of items, there was some confusion for airports that did not have specific items deployed in their EMS. This influenced the participants' responses for these items because they did not have any experience with these items and therefore could not provide an objective response to them. For future research, I would recommend developing the survey questions to reflect more common airport practices and/or providing a "not applicable" choice as an answer for those items that do not apply to the circumstances of the participants.

The second recommendation is for distributing the survey questions and obtaining a larger sample size. Because this study used the survey research methodology, a lot of time of was spent waiting for responses from participants. Although, several reminders were sent to the participants in the survey, the sample size of the second phase survey was relatively small. A possible reason for the small sample size is that fact that the study was conducted in two phases; while the first phase had a relatively good response rate with direct contact with the participants who were airport managers, there was a low response rate from airport

employees who were contacted indirectly. Another possible reason is that the second phase the survey was sent out just prior to the Christmas and New Year holiday season. I would recommend in future research that adequate time is provided, at least three months, for participants to respond especially if this timeframe spans important holidays. I would also recommend more effective ways to motivate participants to finish surveys such as mailing the invitation instead of E-mail and directly calling the related departments.

The last set of recommendations are for future research. The following list was developed in consideration of the findings of the study, participants' answers to the open-ended survey questions, and anecdotal information:

1. Future research could explore the relationship between airport employee/tenant awareness of how their operation impacts the environment and the airports' environmental performance. Employee/tenant awareness of the environment was suggested as factor related to the effectiveness of EMS.
2. Future research could explore the factors that are important is assessing the effectiveness EMS at non-OEP-35 airports or non-hub commercial service airports. This studied focused on the OEP-35 airports because of the scale of their operations.
3. Future research could include a longitudinal study of airports that have implemented EMS. For example, a similar study could be repeated at the

OEP-35 airports in 5 to 10 years and determine if these factors are still relevant or if new ones should be used. This type of study could support the theory of the “Plan Do Act Check” model presented in Chapter 2.

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Appendices

Appendix A

Survey of Factors Related to Assessing the Effectiveness of Environmental Management System (EMS) at airports – Phase 1

1. Does your airport have an Environmental Management System (EMS) in place or is it considering implementing an EMS in the future?

2. What kinds of management programs are used at your airport to help deal with environmental issues?

3. What departments at your airport work directly or indirectly with EMS or a related program?
   Please check the department work directly with EMS or related program with √
   the department work indirectly with EMS or related program with X
   not related leave blank

   ☐Security Department ☐Ground Handling Department

   ☐Quality Assurance Department ☐Finance Department

   ☐Commercial Department ☐Human Resources Department

   ☐IT Department ☐Aviation Services and Business Development Department

   ☐Legal Department ☐Infrastructure Maintenance & Development Department

   ☐Operation Department ☐General Planning & Development Department

   ☐Airport Administration Department ☐Engineering Department

   ☐Others_____ (Please write the name)

☐Others_____ (Please write the name)

☐Others_____ (Please write the name)

4. How do you think EMS can help your airport improve its environmental performance?

5. If your airport does not have an EMS, how is your airport's environmental performance being improved?

6. How would you rank the following factors that may be related to assessing the effectiveness of EMS? Please order the factors with the best listed first and the least effective listed last. Factors:
   - Cost effective (Improving environmental performance with a sustainable cost saving in the long run)
   - Complies with relevant legislation and regulations
   - Improves environmental performance (e.g. reduces emissions, discharges to water, waste and water consumption, saving energy etc.),
   - Improves the airports' public image
   - Increases market opportunity for attracting working partners like attracting more tenants.
   - Other1_____ (Please write down the factor name)
   - Other2_____ (Please write down the factor name)
   - Other3_____ (Please write down the factor name)

7. Please provide any other comments that you think maybe useful in this study.

Appendix B

Survey of Factors Related to Assessing the Effectiveness of Environmental Management System (EMS) at airports – Phase 2

Please respond how strongly you agree or disagree with the following statements concerning the EMS that has been implemented at your airport.
SD-Strongly Disagree D-Disagree N-Neutral A-Agree SA-Strongly Agree

- Environmental Performance
  1. EMS is effective in reducing air emissions from vehicular traffic on the airfield by improving ground transportation circulation or using environment friendly vehicle such as electric vehicle. (E1)
  2. EMS is effective for stormwater discharge. (E2)
  3. EMS is effective in reducing and disposing of solid waste generated by airport operations. (E3)
  4. EMS is effective for reducing the consumption of potable water and its reuse. (E4)
  5. EMS is effective for reducing energy consumption through installing high-efficiency equipment, working on energy management program or Energy Conservation Measures (ECMs) (E5)
  6. EMS is effective in controlling wildlife on the airport. (E6)
  7. EMS is effective in reducing the risk of encountering environmental issues in the future. (E7)
  8. EMS is effective for reducing fuel spills, handling hazardous materials, and handling deicing fluid. (E8)
  9. EMS is effective for inspecting tenants, construction sites, and outfall. (E9)

- Cost effectiveness
  1. EMS helps the airport to reduce the cost of handling environmental issues. (CE1)
  2. EMS helps reduce the time it takes to resolve environmental issues. (CE2)
  3. EMS does not help the airport save money in the long run. (CE3)
  4. EMS helps the airport develop in a sustainable manner. (CE4)
  5. EMS helps the airport in achieving financial sustainability. (CE5)

- Compliance with relevant regulations and legislation
  1. EMS helps guide the airport decision making processes related to the environment and the development. (CO1)

2. EMS provides guidance for airport activities (CO2)
3. EMS helps the airport meet the Federal Aviation Administration's requirements for environmental issues. (CO3)
4. EMS improves employees' awareness of environmental issues and environmental protection (CO4)

- Improve Airport Public Image and Bring Market Opportunities
  1. EMS helps in building a good relationship between the airport and surrounding community. (I1)
  2. EMS helps airport earn awards and recognition for being a good custodian of the environment. (I2)
  3. EMS brings more opportunity for the airport to be exposed to the public through various media. (I3)
  4. EMS attracts more attention from the investors and brings more opportunities for airport sustainable development in the future. (I4)

Please provide the following information:

1. What is your total work experience in the aviation industry in years? ____
2. What airport department do you work for? ____
3. When was EMS implemented at your airport? ____
4. Are there any other factors that you think is important to assess the effectiveness of EMS at airports? ____, ____,_____
5. Do you feel the implementation of EMS has been beneficial to your airport? Please explain why?

Appendix C

IRB Approved Letter

Florida Institute of Technology
Institutional Review Board

Notice of Exempt Review Status
Certificate of Clearance for Human Participants Research

Principal Investigator:	Kainan Li
Date:	September 13, 2018
IRB Number:	18-130
Study Title:	Factors related to the assessment of the effectiveness of environmental management systems (EMS) at airports

Your research protocol was reviewed and approved by the IRB Chairperson. Per federal regulations, 45 CFR 46.101, your study has been determined to be minimal risk for human subjects and exempt from 45 CFR46 federal regulations. The Exempt determination is valid indefinitely. Substantive changes to the approved exempt research must be requested and approved prior to their initiation. Investigators may request proposed changes by submitting a Revision Request form found on the IRB website.

Acceptance of this study is based on your agreement to abide by the policies and procedures of Florida Institute of Technology's Human Research Protection Program (http://web2.fit.edu/crm/irb/) and does not replace any other approvals that may be required.

All data, which may include signed consent form documents, must be retained in a secure location for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Access to data is limited to authorized individuals listed as key study personnel.

The category for which exempt status has been determined for this protocol is as follows:

2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior so long as confidentiality is maintained.

a. Information is recorded in such a manner that the subject cannot be identified, directly or through identifiers linked to the participant and/or
b. Subject's responses, if know outside the research would not reasonably place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing, employability, or reputation.

Appendix D

Correspondence

Morrissey, Scott - DEN <Scott.Morrissey@flydenver.com> Fri, Oct 12, 2018, 5:35 PM
to me, Jeff

Hello – thank you for your interest in Denver International Airport (DEN). DEN CEO Kim Day passed your email along to me, and I would be happy to fill out the survey to support your research project next week.

Best wishes,
Scott Morrissey

SCOTT MORRISSEY
SENIOR DIRECTOR, SUSTAINABILITY
Denver International Airport
Airport Infrastructure Management
8500 Peña Boulevard | Denver, CO 80249-6340
(303) 342-2836 | SCOTT.MORRISSEY@FLYDENVER.COM | WWW.FLYDENVER.COM
Click here to visit DEN on social media

Kainan Li <kli2015@my.fit.edu> Oct 22, 2018, 11:05 AM
to Scott.Morrissey

Good morning, Mr. Morrissey

Sorry for bothering you, just want to remind the survey about Airport Environmental Management System Research. Please feel free to contact me if you have any questions or concerns, really appreciate your help and support and looking forward your feedback. Wish you have a great day!

Best Regards!

to me

Hello – sorry for not getting to it last week, but the survey is attached.

Best wishes,
Scott

Kainan Li <kli2015@my.fit.edu> Mon, Nov 19, 2018, 10:23 AM
to Scott.Morrissey

Good morning, Mr. Morrissey,

Thank you for your kind support for the survey about factors related to effectiveness of EMS at airports and. The following link is the second phase questionnaire for your airport employees. Please forward the link to your employees and encourage them to finish the survey. I really appreciate for your assistance and the support for my study and hope you have a nice day!

Survey link: https://www.surveymonkey.com/r/6JC6DWF

Best Regards!

Morrissey, Scott - DEN <Scott.Morrissey@flydenver.com> Mon, Dec 10, 2018, 8:09 PM
to me

Thanks again. The survey was sent to several DEN staff last week, so I hope you start seeing responses soon.

Hi Kainan: Pls send me a link to your questionnaire so we can see if we can participate in the survey.

Thanks

Ray Scheinfeld
PHL Planning and Environmental Services Manager.

Kainan Li <kli2015@my.fit.edu> Mon, Oct 15, 2018, 3:30 PM
to Raymond.Scheinfeld

Hi, Mr. Scheinfeld,

Really appreciate your assistance, the attachment is the first phase of the survey questions that solicits feedback from airport management. The second phase questionnaire will be created base on the first phase survey's feedback and then send to airport employees. Therefore, currently I only can provide the first phase survey questions and I will send the second phase questionnaire as soon as possible after receiving the feedback. Please let me know if you have any questions and thanks again.

Best Regards!

Aloha Kanani Li,

I can assist with answering some of your questions, but I am swamped over the next few weeks. When do you need the survey back?

Mahalo,

Stacy Paquette
Environmental Health Specialist

State of Hawaii
DOT-AIR EE
400 Rodgers Blvd, Suite 700
Honolulu, HI 96819
P: 808-838-8656

Kainan Li <kli2015@my.fit.edu> Oct 24, 2018, 10:39 PM
to stacy.a.paquette

Hi, Ms. Paquette;

Thank you for your assistance and support, because I need to base on this survey's feedback to create my second phase survey so I would say I need the survey back as soon as possible if it works for you. The survey only have seven questions, it probably only take you ten minutes to finish it. I attached the survey question in this email and please feel free to contact me if you have any questions or concerns. Really appreciate your help and wish you have a great night!

Best Regards!

Kainan Li <kli2015@my.fit.edu> Mon, Nov 19, 2018, 10:24 AM
to Raymond

Good morning, Mr. Scheinfeld,

Thank you for your kind support for the survey about factors related to effectiveness of EMS at airports and. The following link is the second phase questionnaire for your airport employees. Please forward the link to your employees and encourage them to finish the survey. I really appreciate for your assistance and the support for my study and hope you have a nice day!

Survey link: https://www.surveymonkey.com/r/6JC6DWF

Best Regards!

Dalzell, Stewart <SDalzell@massport.com> Fri, Jan 25, 2:42 PM
to me

Good afternoon – I had forwarded your previous email to a colleague here at Logan Airport who is more directly involved with our EMS activities. I will resend in hopes that they respond. Best wishes,

Stewart

Stewart Dalzell, Deputy Director
Environmental Planning & Permitting
Massachusetts Port Authority
617-568-3524 (Office)
617-594-5731 (Cell)

Kainan Li <kli2015@my.fit.edu> Fri, Jan 25, 2:50 PM
to Stewart

Good afternoon, Mr. Dalzell,

Thank you so much for the help. I really appreciate your time and kind support. Wish you have a nice weekend!

Best Regards!

Ramos, Jose A. (Aviation) <JRAMOS@miami-airport.com> Mon, Jan 14, 11:02 AM
to Gustavo, me

Good morning, Kainan:

I am forwarding your inquiry to Mr. Gustavo Leal, Environmental Section Chief in the Civil Environmental Engineering Division, as this questionnaire fall more in line with his expertise.

José A. Ramos, R.A.
Division Director Aviation Planning, Land-Use and Grants
Miami-Dade Aviation Department
P.O. Box 025504
Miami, FL 33102-5504
(305) 876-8080 Phone
(305) 342-9514 Cell
(305) 876-7630 Fax

Good morning, Mr. Strobel,

RE: Request for Assistance in Airport Environmental Management Systems Research

I hope this email finds you well. My name is Kainan Li and I am a graduate student majoring in Airport Development and Management at Florida Institute of Technology. I am currently writing my Master's thesis and have devised a research project with the purpose of determining factors airports can use to assess the effectiveness of environmental management systems. I would like to request your kind assistance and your participation in my research study titled "Factors Related to the Assessment of the Effectiveness of Environment Management Systems (EMS) at Airports".

The survey will only take around 10 minutes to finish, I really appreciate your kind assistance and support. If you don't mind, could you please send the survey link to your colleagues as well to answer the questions. Thank you so much for the help. Below is the survey Link and the attachment is my approved IRB letter from my school. Please feel free to contact me if you have any questions or concerns. Hope you have a great weekend!

Survey Link 1: https://www.surveymonkey.com/r/6JC6DWF
Survey Link 2: https://www.surveymonkey.com/r/XND8WK9

Best Regards!