Cover Page

Title of Design: Funding Essential Air Service to Small Community Airports through Data Driven Decisions

Design Challenge Addressed: IV. Airport Management and Planning

(Submitted April 30th, 2015)

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Executive Summary

There is a lack of empirical evidence to support decisions over the future of Essential Air Service (EAS), a subsidy program that financially supports air travel to remote communities in the United States. In Congress, this has led to a continued debate over the future of the EAS program.

In an attempt to use data to drive future decisions about EAS, our team designed a decision tool to evaluate the reliance remote airports on the EAS subsidy and judge the airport's priority for EAS funding based on data. Our decision model is improved over previous research attempts through the use of multiple decision criteria. Ideas for many of the new decision criteria being used in the model came from interactions with airport and airline stakeholders at an EAS airport.

The decision tool is tested in the scenario of a 20% reduction to the EAS budget, which results in the loss of funding at some EAS airports. It is found that throughout the EAS system, using the designed multi-criteria decision tool provides continued service to an additional 47,000 current EAS passengers while spending $2.5 million less than a previously introduced decision model.

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1 Problem Statement and Background

The Airport Management and Planning Design developed by our team is an improved strategy for airport asset management. Specifically, the asset in consideration is the Essential Air Service (EAS) subsidy, a federally funded program that pays airlines to maintain scheduled flights to remote communities in the United States.

1.1 Current Problem

A problem with the EAS program is that funding decisions are not data driven, but rather based on subjective arguments with limited criteria. For example, cutting EAS funding to a remote airport can affect the airport's eligibility to attain other government subsidies, such as the Airport Improvement Program (AIP) subsidy which is used to maintain "normal" operations through runway upkeep, other maintenance, and even pay for FAA Safety Management Systems. However, measuring the effects on AIP (and other criteria) has never been used in the decision making for future EAS funding.

1.2 Proposed Solution

The developed design is a tool to drive EAS funding decisions with data. The tool uses transportation, census, and airport funding data to compare the reliance of each EAS airport on the EAS subsidy to maintain "normal" operations. The criteria to judge airport reliance on the EAS subsidy is based on a comprehensive literature review and interactions with airport and airline operators. The proposed decision tool is then compared to a prior EAS program reform proposal to compare the costs and benefits of one selection method over another.

This work's purpose is not to base EAS decisions solely on the criteria in this paper. Rather, the greater objective of this work is to introduce a methodological framework in which criteria considered relevant to the EAS subsidy can be considered in the decision making process.

The output of this work is a set of policy recommendations over the future of EAS funding. These policy recommendations strive to improve the efficacy of EAS subsidies to local and regional airports by maintaining funding to the small communities that are most reliant on scheduled air service.

1.3 Prior State of the Art Approaches

Prior decision making research for EAS is limited to proposing only one or two selection criteria on which to base EAS program reform (T. H. Grubesic & Matisziw, 2011; T. H. Grubesic, Matisziw, & Murray, 2012; T. H. Grubesic, Murray, & Matisziw, 2013). For example, the choice of whether to keep or eliminate funding for an EAS route may be based on the surrounding population and passenger load factor (T. Grubesic, Wei, Murray, & Wei, 2014). However, other potentially relevant criteria, e.g. how well the community is connected to the transportation network, is not considered. More importantly, there is no way to introduce other criteria relevant to airport stakeholders and decision makers in the currently available methodologies. These issues are addressed in this work by introducing new decision criteria as well as a platform in which other relevant decision criteria can be added later.

2 Literature Review

2.1 What is EAS?

The Essential Air Service (EAS) program was established in the United States in 1978 after the passing of the Airline Deregulation Act, which gave airlines total freedom to choose which markets they would serve ("Essential Air Service," 2013). To ensure that small communities maintained access to the national air transportation network, the federal government established the EAS program to pay subsidies directly to airlines to schedule flights to communities 70 miles away from a medium/large hub airport. However, since 2001 there has been over a four-fold increase in program costs with only a marginal increase in serviced communities as seen in Figure 1.

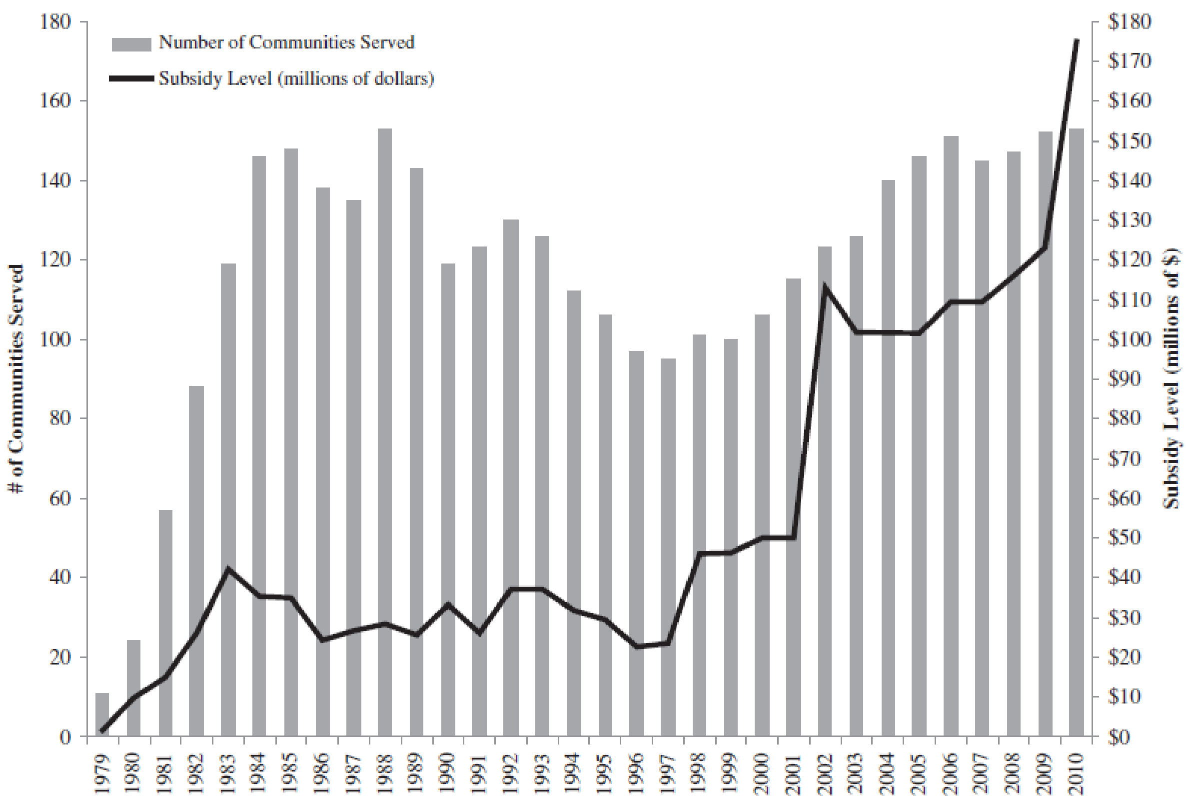

Figure 1. Rising cost of EAS program taken from Matisziw, Lee, and Grubesic (2012).

According to the most recent government report in April 2015, the EAS program costs the United States government nearly $250 million ("Non-Alaska U.S. Carrier Subsidy Reports," 2015) to operate the program in the contiguous United States. Current costs show a stark rise compared to the approximately $50 million the EAS program required to operate in 2001.

This rising program costs has led to debate over the need for EAS both in the federal government as well as among the research community. However, both supporters and critics of EAS lack quantitative information on which to base policy decisions. Resultantly, support and criticism for these programs at a decision making level, such as in the United States Congress, becomes rooted in speculation to satisfy constituent desires rather than based on empirical analysis.

2.2 Regulating EAS: The Political Debate

One of the more recent political debates about the EAS program was on July 30th, 2013, when an amendment proposing to eradicate the EAS program entirely was put to vote in the House of Representatives ("Congressional Record 113th Congress (2013-2014): July 30, 2013," 2013). Although the amendment failed the pass, the fact that there has been voting to eradicate or reform the EAS program in recent years, as seen in Figure 2, reveals that EAS is a current issue that warrants discussion.

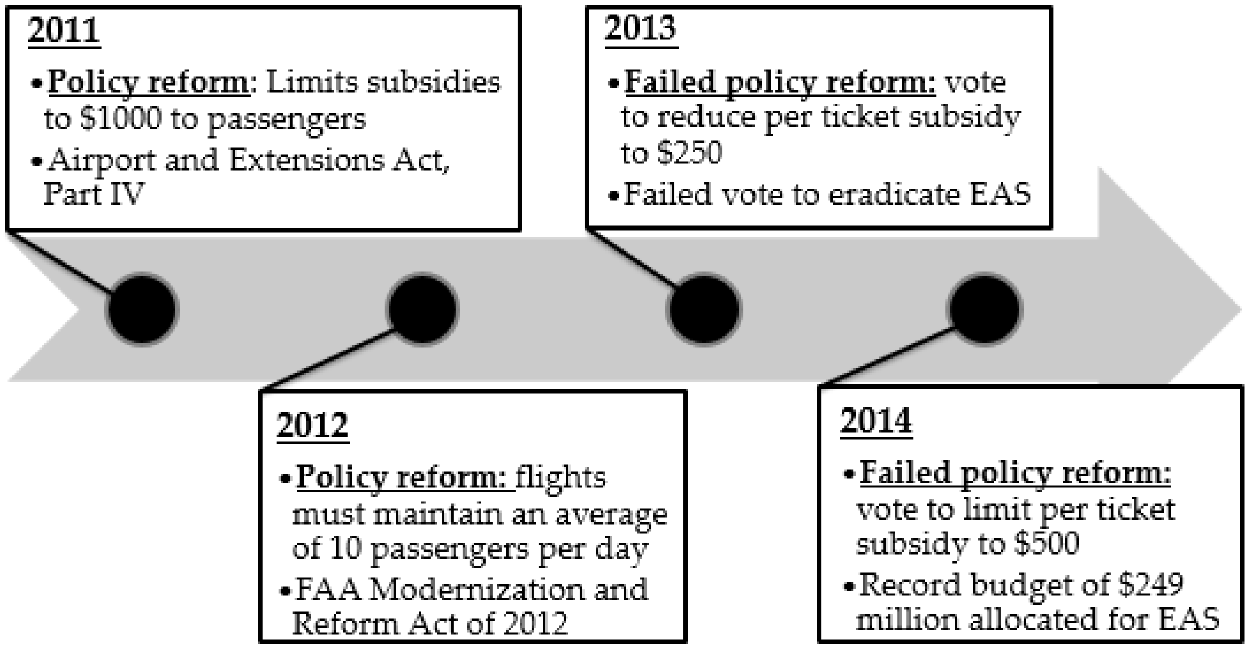

Figure 2. Congressional decisions over EAS policy since 2011.

Pennsylvania Rep. Glenn Thompson has an EAS airport in his district and is a supporter of the EAS program. When the eradication of the program was up for vote in 2011, Rep. Thompson "insisted" that EAS subsidies offer a "good return on investment" (Schaper, 2011). However, no quantitative evidence was provided in support of maintaining EAS subsidies. The contrary argument, from California Rep. Tom McClintock, criticizes EAS as being a wasteful program "that practically nobody uses" (McClintock, 2013). Despite differing opinions of the value of EAS, one commonality is a lack of empirical evidence from both sides of the debate.

2.3 Research to Base EAS Policy Decisions on Data

Recent research has attempted to apply data to improve EAS policy decisions (T. H. Grubesic & Matisziw, 2011; T. H. Grubesic et al., 2012; T. H. Grubesic et al., 2013), but is limited to optimizing EAS to only one or two criteria, such as cost or efficiency.

Grubesic and colleagues have contributed geospatial optimization algorithms that recommend removing funding from EAS airports that satisfy (or fail to satisfy) certain objective functions. The purpose of these optimization algorithms is to reduce inefficiencies in the EAS system to save on federal spending. These objective functions primarily deal with maximizing passenger service in the EAS system by eliminating funding to EAS airports with overlapping service areas (T. H. Grubesic & Matisziw, 2011), within close proximity to hub airports (T. H. Grubesic et al., 2012), or within communities with low population density (T. H. Grubesic et al., 2013).

In Grubesic's work, the criteria that are used to determine passenger service are not fully consistent with how the program is utilized. For example, T. H. Grubesic et al. (2013) defines "demand" as the population residing within a 70 mile radius around a given EAS airport. In order to maximize "demand", the proposed optimization algorithm eliminates funding to EAS airports with the lowest populations until a certain level of financial savings is achieved. Grubesic's cost-benefit analysis concludes that 98% of the population which is currently served by EAS could still be served with a 20% reduction in federal funding of the program. This conclusion brings up two relevant points of criticism.

2.3.1 Validity of Decision Criteria in Previous Research

The first point of criticism is the limited validity in using the population surrounding an EAS airport to define "demand". A larger population does not necessarily equate to higher enplanement numbers or per-capita usage at an EAS airport. On the contrary, higher population numbers often represent communities in more urban and better connected areas. Sparsely populated and geographically isolated communities are linked to higher levels of per-capita EAS service as concluded in another paper by Grubesic and colleagues (T. H. Grubesic & Wei, 2013).

Thus, applying criteria such as EAS utilization and other program benefits to draw conclusions about reforming program policy would provide additional meaningful results.

2.3.2 Enplanements/Capita – Improving the Validity of Decision Criteria

Several studies emphasize the importance of understanding the utilization of remote airports (Adler, Ülkü, & Yazhemsky, 2013; Bråthen & Halpern, 2012; T. H. Grubesic & Wei, 2013; Pita, Antunes, Barnhart, & de Menezes, 2013; Wittman & Swelbar, 2013c), as well as reasons leading to low utilization. Such reasons include losing market share to lower fares and better connections (Lian & Rønnevik, 2011), self-cannibalization of the passenger market in a given region (T. H. Grubesic & Matisziw, 2011), or when an alternative mode of transportation is chosen altogether (T. H. Grubesic et al., 2013; Usami & Akai, 2012). However, none of these aforementioned studies use airport utilization as a decision criteria in subsidy funding reform, particularly in optimization efforts. In other words, the number of passengers actually enplaning at the airports relative to the community size is not considered.

Figure 3 demonstrates the effects of removing funding to EAS airports based on community size alone while not considering utilization. In Figure 3, each vertical bar represents an EAS community. The height of each vertical bars indicates the enplanements/capita for an EAS community, represented as a percent of the left y-axis. The EAS communities are ranked and filed in an ascending order, with communities with the smallest surrounding population on the left and largest surrounding population on the right. The rising slope in the figure represents a cumulative population of residents in a 70 mile radius catchment around each EAS airport, represented as the logarithmic number of residents on the right y-axis. The vertical black bar represents the proposed cut-off point of previous research to improve the EAS system by removing communities with the smallest surrounding population catchments (T. H. Grubesic et al., 2013).

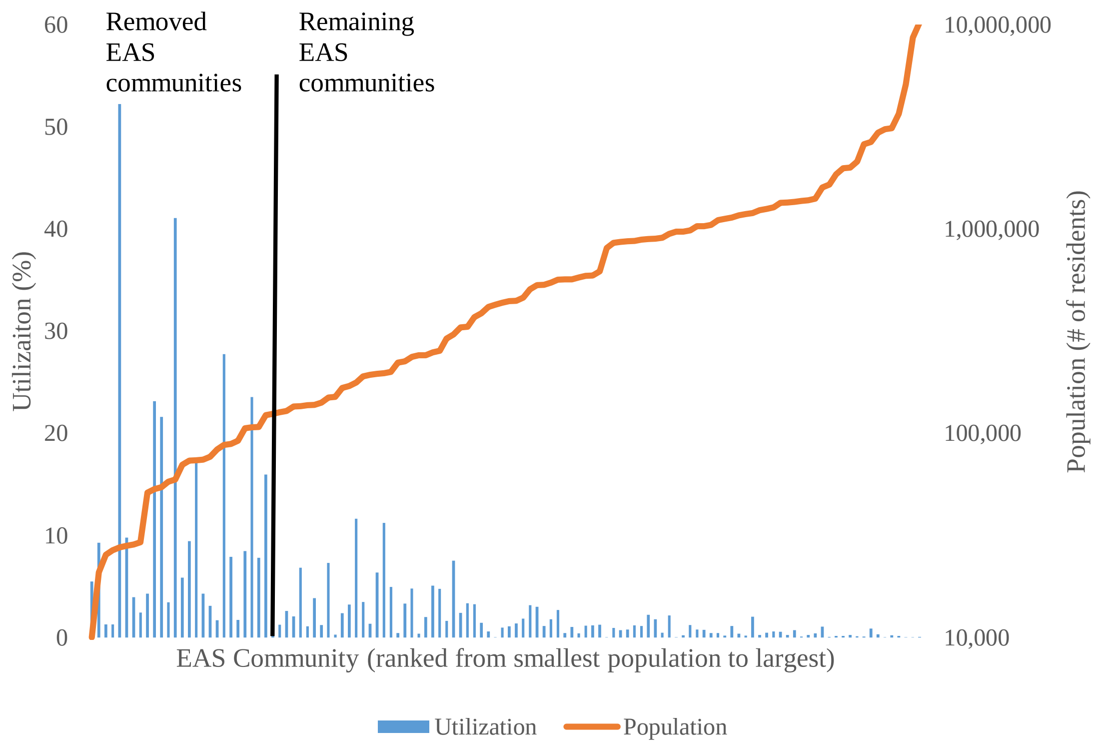

Figure 3. EAS utilization relative to 70 mile radius population catchment

As can be seen from the figure, the EAS communities that would be removed from the program if the selection criteria was based on surrounding population alone (left of the black vertical bar) have some of the highest utilization numbers.

Thus, the proposed research first uses airport utilization – defined as total enplanements over community population – as an alternative decision criteria to calculate the importance of scheduled air service for a given EAS community.

2.3.3 Freight/Mail, AIP – Unconsidered Benefits and Costs

The second point of criticism to previous EAS reform research is a lack of empirical analysis of the benefits and costs to other stakeholders resulting from the presence of EAS. For example, the eradication of EAS service to an airport may cause an airport to lose its eligibility for other federal funding.

EAS subsidies are paid to the airline for maintaining a minimum level of air service to a remotely located community with an EAS eligible airport ("Essential Air Service," 2013). In turn, a given number of passengers enplane at the EAS eligible airport. The number of passenger enplanements then affects how other subsidies are awarded. One example is the FAA Airport Improvement Program (AIP), which is paid to the airports and not the airlines. Although these are different subsidy programs, they are nonetheless linked as shown below.

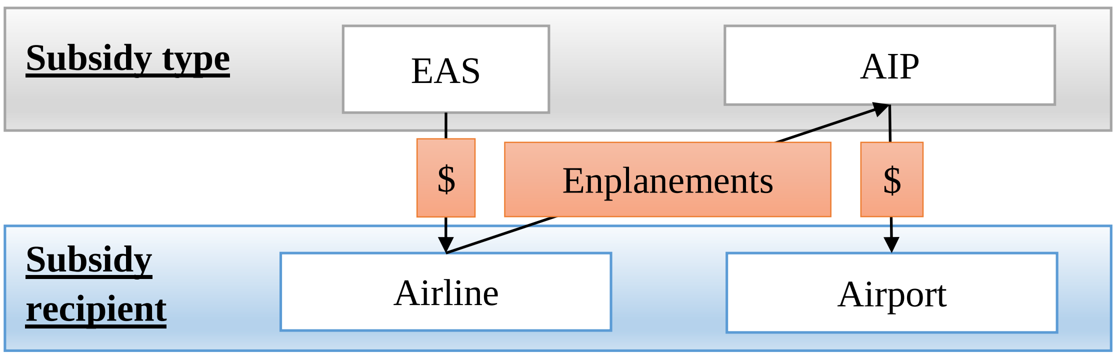

Figure 4. Linkage between subsidy programs at remote US airports.

In the United States, an airport must maintain 10,000 enplanements annually in order to maintain status as a “primary commercial airport”. As a primary commercial airport, an airport is eligible for a base funding of 1,000,000 USD through the AIP. These funds can be used for airport facilities and maintenance, such as repairing runways and aprons, purchasing snow removal equipment or paying for wildlife management. If an airport’s annual enplanement drops below 10,000 passengers, then the amount of AIP eligibility for an airport’s general upkeep and maintenance is reduced.

The team’s interaction with airport and airline operators identified other stakeholders, aside from the operating commercial airline, that also have a stake in AIP funding at EAS airports. Examples of groups that depend upon the upkeep and maintenance of EAS airport facilities include general aviation traffic, military overflow traffic, freight/mail operations, and the municipality which operates the airport.

One such community that could potentially lose its “primary commercial airport” status is Dickinson, ND, which is home to Theodore Roosevelt Regional airport. The 70 mile catchment around Dickinson, ND is home to a relatively sparse 59,426 residents ("Census Data," 2010), and from November 2011 to October 2012 the airport handled 24,410 enplanements ("BTS Air Traffic Data," 2012) along the EAS route. Despite the relatively high number of enplanements, due to the relatively low number of residents compared to other EAS airports, Dickinson, ND would be eliminated if one utilized the Grubesic optimization algorithm to maximize passenger service based on “demand”. In doing so, the airport would no longer be eligible for “primary commercial airport” status funding. However, in the same 12 month span that Dickinson enplaned 24,410 passengers, and over 621,000 lbs. of freight and mail also passed through Theodore Roosevelt Regional airport.

If the community of Dickinson were to lose its status as a “primary commercial airport”, then the reduction of funding for maintenance and improvement of airport facilities may affect the ability of freight/mail operations to function at their current levels. Thus, it is important to consider the effects of eradicating EAS service to a given airport from the perspective of the airport’s status, as well as the presence of other services such as freight/mail.

2.4 Additional Decision Criteria of EAS

2.4.1 Disaster Response – An Airport’s Contribution to Regional Disaster Recovery

Recent research has also cited the contribution of remote and regional airports to the resilience of the transportation network in the wake of a disaster (Donehue & Baker, 2012; Smith, 2010). For example, traffic can be diverted to a small airport when a primary airport becomes incapacitated. Even a recent Synthesis released by ACRP (Smith, 2014) highlights the importance of cooperation among airports in dealing with emergency management. However, if an EAS airport were to lose EAS subsidies, which in turn could lead to a reduction of AIP funding, a small community airport may not be prepared to handle a disaster in a close proximity.

Using the earlier case, Dickinson, ND has an EAS airport that is at risk of having its passenger enplanements drop below 10,000 enplanements/year if it were to lose its eligibility for EAS subsidy. If that were to be the case, Dickson, ND would also lose its status as a primary commercial airport and resultantly be at a lower tier for AIP funding. In 2013, the nearly $2 million Dickinson, ND received in AIP funding was primarily used to rehabilitate the several taxiways ("AIP Grant Histories," 2013). If the taxiways are in a state of disrepair, the airport in Dickinson, ND may not have the appropriate facilities to handle emergencies. Maintaining appropriate emergency procedures is rather relevant to Dickinson, ND since according to historical Federal Emergency Management Agency (FEMA) data, Stark County – the county that Dickinson, SD resides in – declares a federal emergency on average once every four years (FEMA, 2015).

Applying established notions that regional airports are vital in handling surrounding emergencies, this research proposes using the historical number of disasters surrounding an EAS airport as an indicator of the likelihood that the EAS airport will be called to use in an emergency situation. Furthermore, the likelihood that an EAS airport will be required to handle an emergency situation will be used in the decision making process of future EAS funding.

2.4.2 Road Density – A Measure for Access

Access and connectivity of a remote community was regarded as one of the most relevant benefits of remote air transport (Bråthen & Halpern, 2012; T. H. Grubesic & Matisziw, 2011; T. H. Grubesic et al., 2012; T. H. Grubesic & Wei, 2013; Özcan, 2014; Wittman & Swelbar, 2013a, 2013c). Distances between the EAS communities and hub airports has served in previous research as an optimization criteria in which to improve the EAS program (T. H. Grubesic & Matisziw, 2011; T. H. Grubesic et al., 2012). A shortcoming in using the distances from the EAS airport to the nearest hub airport as a selection criteria for optimization is that distance alone does not reflect the level of connectivity.

For example, the distance between two different EAS airports and the nearest large/medium size hub may be similar, but the amount of roads accessing that area may be different. Take the case of the following pairs of EAS airports and their respective nearest Medium/Large Hub airport (Bureau of Transportation Statistics, 2014):

- Watertown, NY (EAS) – Buffalo, NY (Medium/Large Hub); distance 172 miles
- Cedar City, UT (EAS) – Las Vegas, NV (Medium/Large Hub); distance 179 miles

Although the distances between the EAS community and nearest medium/large hub are similar, what the distance data alone fails to capture is that Watertown, NY is in a relatively developed area compared to Cedar City, UT. Watertown, NY is about an hour north of the city of Syracuse, NY, whereas Cedar City, UT is in the middle of the desert at the edge of several National Parks. Consequently, residents of Watertown, NY may also access Syracuse Hancock International Airport (a Small Hub airport only 54 miles away) while the nearest hub airport for Cedar City, UT requires the 179 mile commute to Las Vegas, NV.

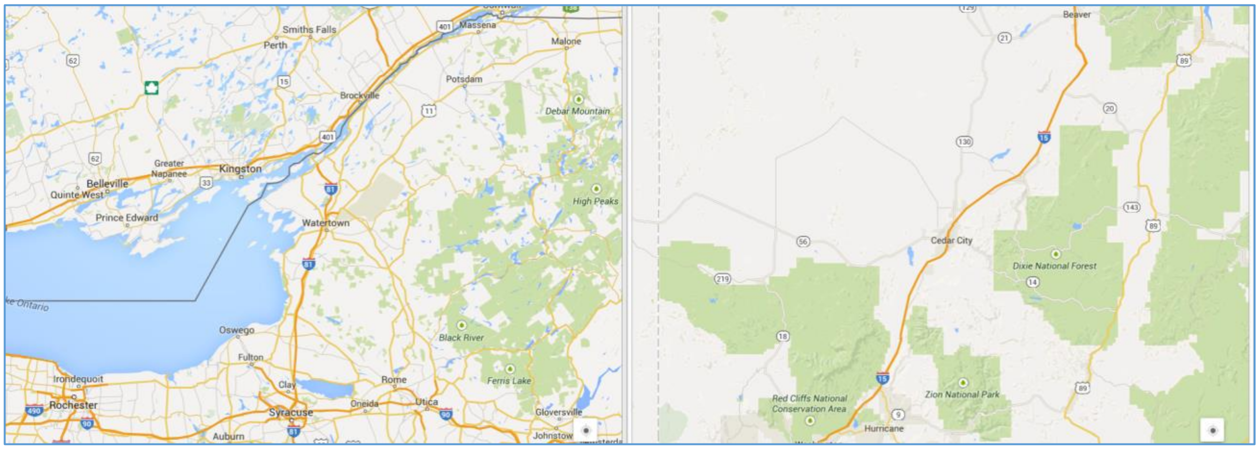

Figure 5. Google Map of Watertown, NY on left and Cedar City, UT on right at same zoom level.

Figure 5 is a side-by-side screenshot of Watertown, NY and Cedar City, UT (both centered) at the same zoom levels. The lines on the map indicates the roads in the surrounding areas. Judging by the maps, Cedar City, UT is surrounded by less roads and thus can be considered more remotely located than Watertown, NY.

This research proposes to characterize access based on road density (miles of highway per 70 square mile tract around the EAS airport) to better capture the remoteness of a community. In the example above, since Cedar City, UT is seemingly more remote than Watertown, NY, the road density surrounding Cedar City, UT is expected to be less dense than the area surrounding Watertown, NY. Utilizing the road density characterization, this research attempts to improve upon the current definition of remoteness when used as a selection criteria and incorporate it into the overall EAS decision making tool.

2.5 Summary of Literature Review

The literature review has identified several points that should be considered when deciding the future of EAS funding:

1) Enplanements/capita – the utilization of an EAS airport.
2) Freight/mail operations – a measure of how many non-commercial operations are happening at an EAS airport.
3) AIP funding – the reliance of a small community airport on the EAS subsidy to gain additional funding.
4) Number of disasters surrounding an EAS airport – the number of historically reported disasters in the immediate area surrounding an EAS airport will serve as a proxy for the likelihood the EAS airport will be utilized in the wake of an emergency.
5) Road density of an EAS community – the level of connectivity an EAS airport has to the transportation network.

A common trait that these points share is that they have been identified in previous research as important to consider when deciding which EAS airports to fund; however they have never been analyzed in an empirical manner across the EAS system. Furthermore, they have never been used simultaneously in an analytical decision making process for the future of EAS funding.

3 Problem Solving Approach

The literature review identified several data based criteria to drive EAS funding decisions. To incorporate different criteria into one decision, the following engineering steps are employed:

1. Data collection – data is first collected from the US Department of Transportation (US DOT), Federal Aviation Administration (FAA), US Census and FEMA, then processed using geospatial analysis techniques in ArcGIS software.
2. Ranking and weighting – the several data classes are joined using a quartile ranking technique to identify airports most reliant on the EAS subsidy.

3. Decisions on funding – this step describes the effects on the EAS system at certain levels of funding rollbacks.

3.1 Data Collection

First, a list of EAS airports and the amount of EAS funding each airport is receiving is taken from the United States Department of Transportation's (US DOT) website on EAS ("Non-Alaska U.S. Carrier Subsidy Reports," 2012). For the purpose of this study, the EAS report utilized is from October 2012 for all EAS airports excluding Alaska. Alaska was not considered in this analysis as their unique geographic situation makes their funding requirements differ to the rest of the US. Furthermore, although data from EAS 2012 was utilized, the proposed design can be applied to the latest data sets as well.

The October 2012 EAS data identifies 120 airports (not including Alaska) receiving approximately $225 million for 12 months of operation. An example of the data from the US DOT website on EAS is seen in Figure 6.

Total	State	EAS Community	Subsidy Rate @	EAS Carrier	EAS Docket	Rate Ends	Current Order	Hub	Aircraft	Seats
1	Alabama	Muscle Shoals	$2,603,365	Silver	00-7856	Sep 30-14	2012-5-17	ATL	SAAB 340	34
1	Arizona	Kingman	$1,168,390	Great Lakes	96-1899	Apr 30-13	2011-3-4	PHX	B-1900	19
1	Arizona	Page	$1,559,206	Great Lakes	97-2694	Apr 30-13	2011-3-4	PHX	B-1900	19
1	Arizona	Prescott	$1,832,233	Great Lakes	96-1899	Apr 30-13	2011-3-4	LAX/DEN	B-1900	19
1	Arizona	Show Low	$1,719,058	Great Lakes	98-4409	Apr 30-13	2011-3-4	PHX	B-1900	19

Figure 6. Example of EAS data provided by US DOT.

3.1.1 Enplanements/Capita

To capture the relative utilization of an EAS route in a given community, a measure of enplanements must be collected, followed by population data. Dividing the enplanement data by the population data and multiplying by 100 provided a relative percentage of enplanements/capita in the area surrounding an EAS community.

Enplanement data at a given airport is taken from the US DOT Bureau of Transportation Statistics (BTS) ("BTS Air Traffic Data," 2012), as shown below. For each EAS airport, the total number of enplanements is collected for the 12 month period leading up to October 31, 2012 to correspond with the EAS subsidy data. The number of enplaning passengers ranged from eight airports enplaning less than 1000 people each (mainly in Montana and Georgia) to Plattsburgh, NY with over 101,000 enplanements.

Some EAS airports have flights along EAS routes and non-EAS routes. In these cases, both values are noted so that the reliance of an airport on EAS funding can later be calculated. An example of the US DOT BTS data is found in Figure 7.

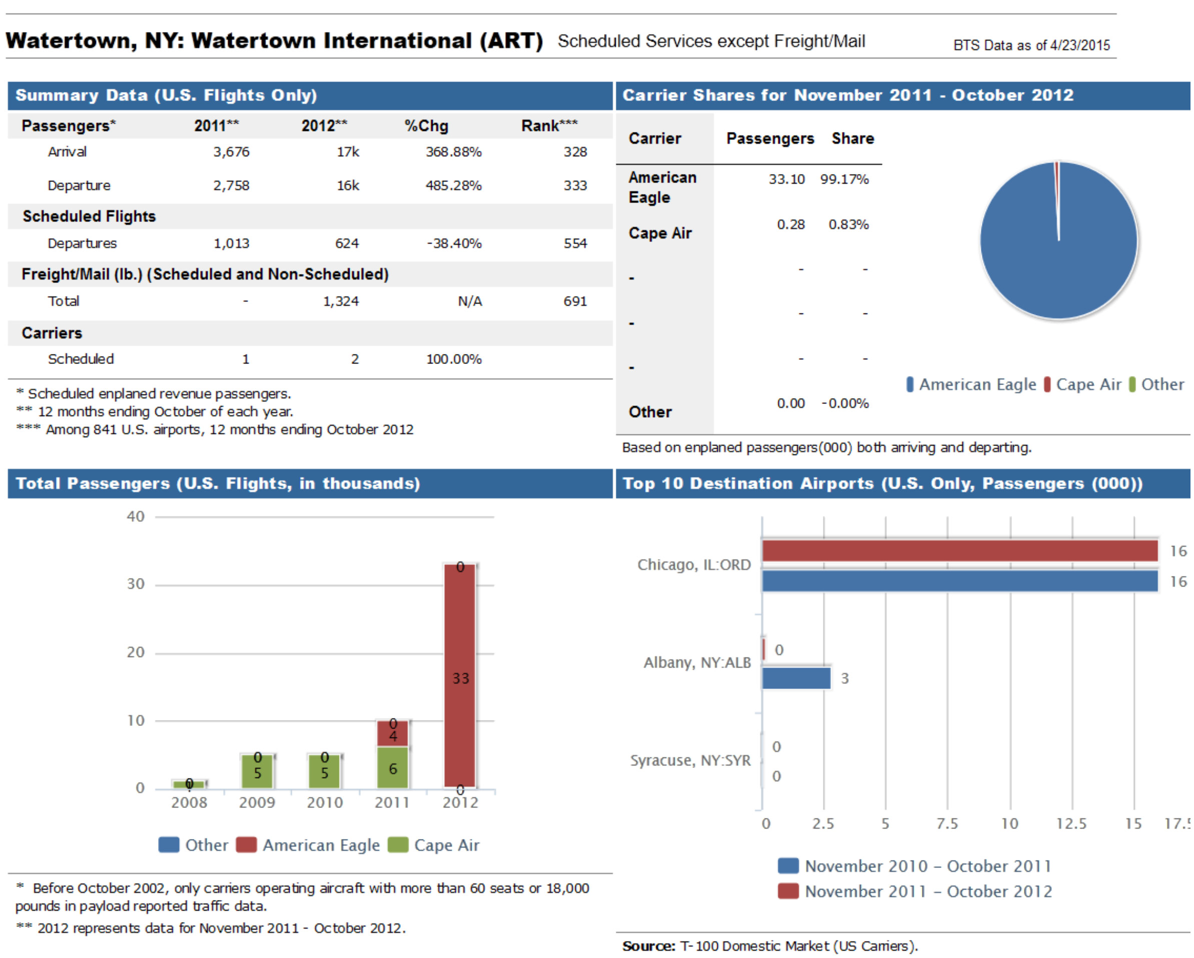

Figure 7. Example of airport data presented on the US DOT BTS website.

Population data is taken for a catchment of a 70 mile radius around the EAS airport. The 70 mile radius was chosen based on initial eligibility standards that required EAS communities to be at least 70 miles away from a medium or large hub airport. The zip code the EAS airport is located in was used as the center of population catchment area. The Missouri Census Data Center ("Missouri Census Data Center," 2015) was used as a resource to search 2010 US Census population numbers within a 70 mile radius of the EAS airport.

The population sizes around EAS airports ranged from 10,300 person in Ely, NV – a town in the Nevada desert surrounded by National Parks – to 10,268,181 persons in Lancaster, PA – a town located about 80 miles away from Philadelphia and Baltimore.

3.1.2 Freight/Mail Operations

The freight/mail data was also taken from the US DOT BTS database for the 12 month period leading up to October 31, 2012. The data collected accounted for the total weight (in lbs.) of scheduled and non-scheduled freight and mail traveling through the EAS airport. Freight data was unavailable for four of the 120 airports. In the case which data was unavailable, it was assumed that no freight was handled during this time frame. The range of freight/mail handled at EAS airports ranged from zero lbs. (or not reported) at 43 airports to over 2 million lbs. as in the case of El Centro, CA.

3.1.3 AIP Funding

An EAS airport's eligibility for AIP funding was calculated based on the enplanements figures from the US DOT BTS. First, airports with more than 10,000 enplanements were classified as a "primary" commercial airports. Table 1 contains further details about small airport classification and funding eligibility.

Table 1. AIP funding eligibility at EAS airports.

Airport Classification (with commercial service)	Enplanements	Minimum AIP funding eligibility
Primary	More than 10,000	$1,000,000
Non-Primary	At least 2,500 and not more than 10,000	$150,000

Then, the number of enplanements along EAS routes were subtracted from the total number of enplanements at each EAS airport that is considered "primary". If the resulting value would drop below 10,000 enplanements, that airport would be marked LP, as potentially losing primary status. The EAS airports that maintained primary status in spite of a loss of their EAS route(s) were indicated to have no effect.

3.1.4 Declared Disasters

Declared disasters were measured using the average number of declared disasters per community within a 70 mile radius of an EAS airport. (Once again, the 70 mile demarcation is chosen to correspond to the original eligibility criteria of an EAS airport's distance from medium/large hub.) The number of declared disasters per community was downloaded from the FEMA database (FEMA, 2015) in a geographic information system (GIS) format. In other words, the team accessed a map of every county in the US with every disaster declared to FEMA in the last 50 years indexed by county.

This map was then put into ArcGIS, a geographic information system software. A map of every EAS airport was overlaid onto the declared disasters map. A circle of 70 mile radius was drawn around each EAS airport. The average number of historical disaster declarations was taken for every county that was contained in the 70 mile circle as well as for every county that the circle intersected.

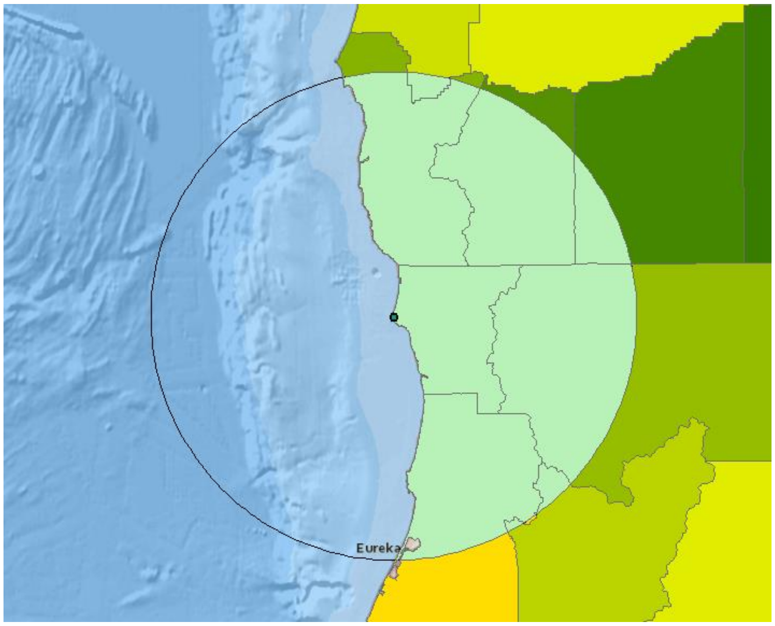

Figure 8. Example of 70 mile circle around Crescent City, CA airport from ArcGIS screen capture.

Figure 8 is an example of the 70 mile radius drawn around the EAS airport in Crescent City, CA. The counties are represented in a gradient of colors, with the lighter colors signifying communities with a higher number of declared disasters.

By utilizing an average number of disasters rather than an absolute count, the team was able to reduce bias towards EAS airports surrounded by a higher density of counties. The number of average disasters in counties surrounding an EAS airport ranged from 0.4 in Pellston, MI to 20.9 in Devil's Lake, ND. In other words, not every county in the immediate vicinity of Pellston, MI has reported a disaster in the past 50 years. Conversely, the counties surrounding Devil's Lake, ND each report a disaster to FEMA on average once every 2.5 years.

3.1.5 Road Density

A road density measure was calculated in ArcGIS by once again applying a circle of 70 mile radius around each EAS airport, and measuring the miles of highway within those 70 miles. Highway data was taken from ArcGIS software roadmap database.

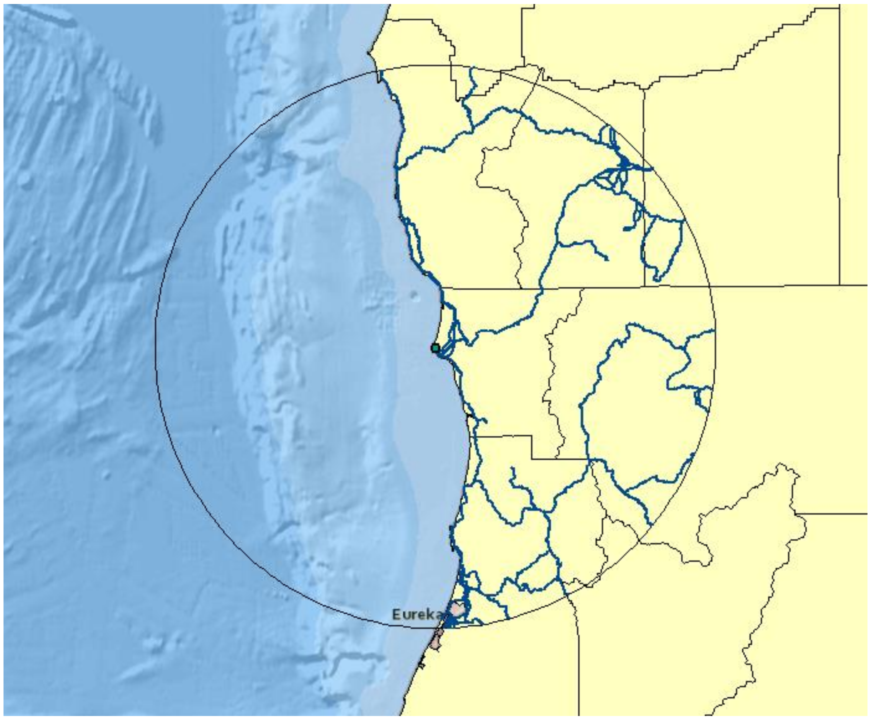

Figure 9. Example of highways within a 70 mile radius of Crescent City, CA airport from an ArcGIS screen capture.

Figure 9 shows the highways within the circle of 70 mile radius with the EAS airport as the center. The miles of highway for the entire area is then converted to miles of road per 100 sq. miles to capture an average.

The road density ranged from 5.0 miles of road / 100 sq. miles in the area around Greenbrier/White Sulphur Springs, WV up to 90.9 miles of road / 100 sq. miles in the area surrounding Hagerstown, Maryland.

3.2 Ranking and Weighting

For the decision criteria with an associated numerical value – enplanements/capita, freight/mail operations, declared disasters, road density – the airports are ranked from 1 to 120 based on the potential benefit an EAS subsidy may have for the community with respect to that given criteria. A weighting of 3,2,1,0 were assigned to each airport depending on the quartile of their ranking. (Airports ranked 1-30 were assigned a 3, 31-60 were assigned a 2, and so on.) A higher weighting value indicates a higher reliance on the EAS subsidy with respect to the given criteria.

Ranked in descending order

- Enplanements/capita – a community with a high percentage of enplanements/capita is ranked higher than a community with low enplanements/capita. A citizen that is residing in a community with a high enplanements/capita value may be more likely to use the EAS service, thus EAS would have more benefits to these communities.
- Freight/mail operations – a community with a high volume of freight/mail operations is ranked higher than a community with a low volume freight/mail operations. An EAS airport that is handling more freight/mail is more likely to require upkeep and maintenance at the airport; e.g. the runway and taxiways need to be repaired, wildlife needs to be mitigated, et cetera. Thus, airports with high volumes of freight/mail passing through may be more dependent upon the continual flow of subsidies to pay for the upkeep than airports with no freight/mail operations.
- Declared disasters – a community with a high number of declared disasters in the surrounding communities is ranked higher than a community with a low number of declared disasters in the surrounding community. The likelihood that an EAS airport may be utilized in disaster relief efforts are higher when the EAS airport is in a location that is historically more prone to disasters.

Ranked in ascending order

- Road density – a community with lower levels of road density is ranked higher than a community with a higher level of road density. Communities with lower levels of road density may be less connected to the transportation network. Resultantly, these communities may benefit more from the presence of EAS.

Classified instead of ranked

- AIP – for judging an EAS airport's reliance on the AIP subsidy, each airport was not ranked but instead classified based on if the airport 1) is at risk of losing primary status with the loss of EAS subsidy and 2) reports freight/mail operations (to serve as an indicator for being a multipurpose facility). For this study, airports that rely on EAS subsidies for passenger enplanements to maintain primary status are considered more reliant on the EAS subsidy than airports' whose primary status will not change with the loss of EAS. Within each subset (airports reliant on EAS for primary status, airports not reliant on EAS for primary status), airports with freight/mail operations are deemed more reliant on maintaining funding since the airport is used beyond scheduled passenger service and general aviation. Table 2 breaks down the weighting for each airport classification.

Table 2. Weighting given to each EAS airport based on the airport's reliance on EAS to attain AIP subsidy and the potential impact on other airport uses.

At risk of losing primary airport status	Freight/mail operations at airport	Weighting given	Number of EAS airports
Yes	Yes	3	14
	No	2	16
No	Yes	1	58
	No	0	32

3.3 Decisions on Funding

The possible weight score an EAS airport can receive ranges from 0-15. A higher weight score indicates an airport more reliant on EAS subsidy to continue "normal" operations based on the considered criteria. The following selection model, adapted from T. H. Grubesic et al. (2013), is then applied:

$A =$ set of all airports
$i =$ index of EAS airports
$w_i =$ weight of score for airport $i \in A$
$c_i =$ cost of airport $i \in A$
$B =$ budget

$$X_i = \begin{cases} 1 \text{ if airport } i \text{ is chosen} \\ 0 \text{ otherwise} \end{cases}$$

$$\text{Maximize} \sum_{i \in A} w_i X_i \qquad (1)$$

Subject to:

$$\sum_{i \in A} c_i X_i \leq B \qquad (2a)$$

and/or

$$\sum_{i \in A} X_i \leq p \qquad (2b)$$

$$X_i \in \{0,1\} \; \forall i \in A \qquad (3)$$

Objective (1) maximizes the weight scores of EAS airports remaining in the system. Constraint (2a) sets a budgetary constraint, constraint (2b) requires exactly p airports to be kept in the system. Constraint (3) is an integer requirements for the variable.

In other words, the model selects EAS airports for funding based on their weight scores until a desired amount of airports remaining in the system is reached. The desired amount of airports may depend on the amount of financial savings attempting to be achieved.

4 Practicality and Feasibility

4.1 Results: A Cost-Benefit Analysis

Applying the multi-criteria decision model, the value of p is estimated at 93 to achieve approximately a $45 million savings, or 20% of 2012 EAS program costs. Table 3 captures the remaining EAS transport system if 27 airports have funding removed based on using the multi-criteria decision tool proposed here versus Grubesic's single criteria spatial optimization model (i.e. population tract around EAS community) found in earlier work. The values are given with respect to airports remaining in the EAS system.

Table 3. Capture of EAS system if 20% budget cut is applied.

	Current EAS system (Oct 2012)	Multi-criteria decision tool	Spatial optimization only	Advantage
Number of airports maintaining EAS subsidy	120	93	93	N/A
Total costs of subsidy for airports remaining in the EAS system ($)	224,995,751	**178,939,339**	181,421,014	Multi-criteria
Sum of population tract	104,157,489	48,484,628	**102,395,323**	Spatial only
Sum of enplanements	1,144,511	**970,134**	922,742	Multi-criteria
Enplanements/capita (%)	4.00	**5.01**	1.77	Multi-criteria
Sum freight/mail (lbs.)	21,913,440	**21,660,161**	16,826,020	Multi-criteria
Airports w/ primary status eligible for AIP	30	**30**	19	Multi-criteria
Average number of declared disasters/county	8.7	8.7	**9.2**	Spatial only
Road density (miles road/100 sq. miles)	31.7	**26.2**	36.4	Multi-criteria

4.1.1 Benefits

The benefits of the multi-criteria approach is a 20.4% reduction of costs from the EAS program ($46.1 million saved), whereas the spatial optimization approach saves 19.3% of the EAS program costs ($43.6 million saved), each with a loss of funding to 27 airports. The multi-criteria approach is able to serve an equal amount of communities with a $2.5 million savings.

4.1.2 Costs

Since the spatial optimization model has the single objective to maximize the population tract, 98.3% of the population surrounding EAS airports is still served with the single objective decision approach. Only 46.5% of the population around EAS communities remain served with the multi-criteria tool. However, the 46.5% of the population chosen by the mulita-criteria accounts for 84.7% of the total enplanements along EAS routes. Using the single criteria model, the additional 51.8% gained in population served only results in a 4% increase in enplanements. These results are reflected by the utilization numbers in the funded airports, with the multi-criteria approach increasing the enplanements/population to 5.01% whereas the single criteria approach reduces the enplanements/passengers to 1.77%.

The multi-criteria approach keeps all 30 airports that currently have AIP primary status, whereas the single criteria approach removes EAS funding from 11 airports currently with AIP primary status. With the multi-criteria approach, the sum of freight/mail handled at EAS airports to lose funding is only 1.1% (253k lbs.) of the total, whereas the single criteria approach removes funding at EAS airports handing 23.2% (5.09 million lbs.) of freight/mail.

The multi-criteria approach exhibits no change in the average amount of declared disasters compared to the current EAS system (8.7 declared disasters/county), whereas the single criteria approach slightly improves to an average 9.2 declared disasters/county. The road density average decreases from 31.7 miles/100 sq. miles in the current EAS system to 26.2 miles/100 sq. miles with the multi-criteria approach and increases to 36.4 miles/100 sq. miles for the single criteria approach.

4.2 Discussion: Potential Real-World Impact

Based on the chosen criteria, deciding which EAS airports should maintain funding using a multi-criteria decision tool first resulted in funding communities which more heavily used and relied on EAS services. This aspect is captured the increase in enplanements/capita percentage of the remaining airports in the EAS program. The comparatively higher number of enplanements/capita (and absolute enplanements) using the multi-criteria approach indicates that serving a larger population does not lead to higher usage of the EAS program.

The figure below is a count of airports that would lose EAS funding, separated by FAA region.

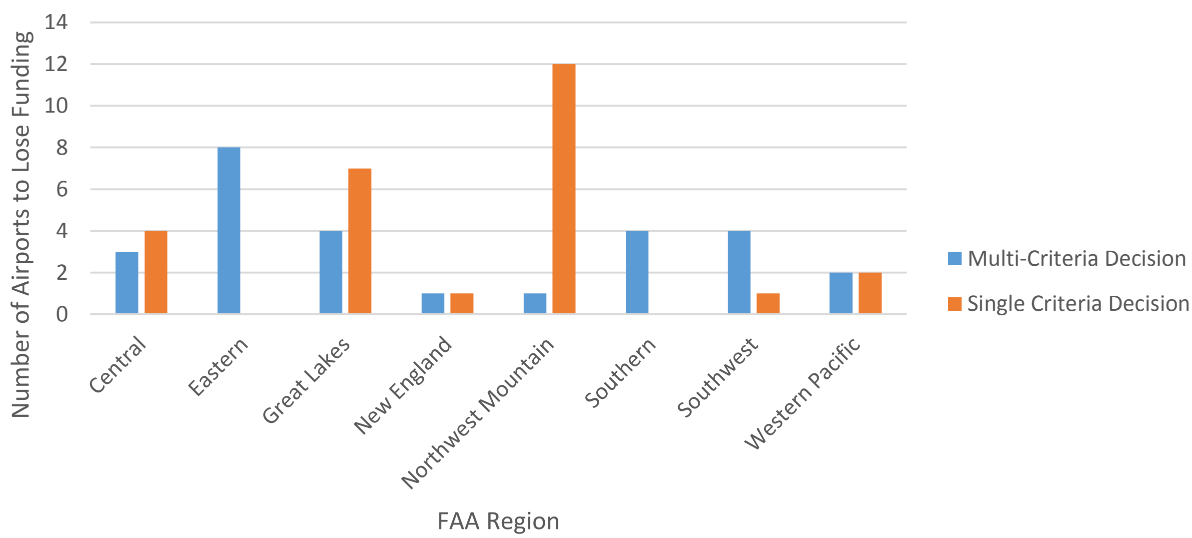

Figure 10. Number of airports losing EAS subsidy by FAA region.

Of the EAS airports that would lose funding, the greatest reduction in EAS service with the multi-criteria approach occurs in the Eastern FAA Region. Within the Eastern Region, a total of eight EAS airports would lose funding with Pennsylvania losing subsidies at four airports. The single criteria decision targets the Northwest Mountain FAA region, with Montana losing subsidies at eight airports. Montana is one of the least populous states while Pennsylvania is one of the most populous states ("Census Data," 2010). Furthermore, the road density surrounding EAS airports in Montana is 16.5 miles/100 sq. miles compared to Pennsylvania having 60.8 miles/100 sq. miles. Thus, the multi-criteria selection favors funding airports in smaller communities that are measurably more remote.

Secondly, using the road density as a decision criteria generally removed funding from EAS communities that are measurably less remote. An exception is the case of Kalaupapa, Hawaii, in which the surrounding highways were reported at a density of 106.5 miles/sq. miles. However, Hawaii being an archipelago may experience different problems with remoteness and connectivity than the contiguous United States and may need to be considered separately.

Thirdly, using the multi-criteria decision would not put any primary status EAS airports at risk for losing their higher eligibility level of AIP funds. This finding implies that a majority of airports remaining in the reformed EAS system could continue handling the bulk of EAS freight/mail operations, 98.9%, without worrying over losses of AIP subsidies.

Fourthly, there is no change in the average declared disasters between the original EAS system and EAS system reformed through the multi-criteria approach. This implies that some regions, such as the New England FAA region, are losing EAS coverage in high disaster areas. Other regions, such as the Southern region, are losing EAS coverage in areas with relatively low disaster count, leading to coverage in more disaster prone areas.

4.3 Limitations and Implementing the Design

Although the design demonstrates an improvement over previous efforts, the design's main limitations are still 1) the decision criteria used, 2) the assignment of weightings, and 3) assumption over what happens when EAS subsidy is removed.

First, the decision criteria used in this design were based on interviews with airport and airline stakeholders at only one EAS airport as well as through a comprehensive literature review. However, the relevance of decision criteria may differ from one geographic region to the next. Furthermore, available research and literature may not adequately consider all factors affecting EAS service. To fill this gap, a broader study of EAS effects is required.

Secondly, all criteria had the same amount of maximum (3) and minimum (0) score that could be contributed to the final decision. In actuality, one criteria (such as enplanements/capita) may be deemed more important than another criteria and should be given more weighting. Within each criteria itself, the possible scores depended on each airport's rank against each other to establish a score. In actuality, a greater level of granularity may exist with respect to how much weight differs between the highest and lowest score of one criteria.

Having a greater level of granularity in the weight scores can also reduce some ambiguity in the selection process. For example, for this work the selection model required picking four airports that had a weight score of 5 for elimination of EAS subsidy. Since there were more than four airports with a weight score of 5, a random selection process was used for the purpose of the study. In the future, a more granular weight score would allow more precise selection techniques.

Thirdly, in this study EAS routes are assumed to reach zero when the subsidy is removed. In actuality, this may not be the case and EAS routes may continue to be profitable in an unsubsidized state. Studying the sensitivity of EAS routes to subsidy loss would provide more accurate findings on operations in the wake of subsidy loss.

4.3.1 Follow Up Surveys

In order to improve decision criteria and assignment of weightings, future work should begin with two surveys to stakeholders of airports and airlines along EAS routes. The first survey should inquire about the relative importance of the criteria brought up in this work, as well as give an opportunity for stakeholders to note other decision criteria which they deem important. This is an opportunity to validate the introduced decision criteria and judge if more are necessary.

The results from the first survey should be used in a second survey to better understand the relative weighting within each criteria. The feedback from the stakeholders can be organized and analyzed using a structured decision making process, such as the Analytical Hierarchy Process, to reassign criteria weightings.

4.4 Policy Recommendations: Meeting National Needs

The following policy recommendations are made to improve EAS program decision making:

1. <u>EAS program eligibility should be decided on more than one criteria.</u> As demonstrated in this work, deciding the future of EAS with only one criteria does not capture many relevant effects of the subsidy.
2. <u>Deciding criteria should come from airport and airline stakeholders as well as decision makers.</u> The ideas for this work came from interacting with airport and airline managers from one region. A broader survey of what is important to EAS stakeholders nationwide can better hone in on the most relevant decision criteria.

3. Using decision criteria such as road density or enplanements/capita may better capture the actual "remoteness" of an EAS community. As shown earlier, two EAS airports of equal distance to a hub airport may be starkly different in the level of access at each airport. This difference may not be well enough captured using only distance – a current judging criteria for EAS eligibility.

4.5 Safety and Risk Assessment

The proposed decision tool targets airport management at the policy making level. The work itself does not have any inherent risks, but rather aims to mitigate indirect risk in two ways.

First, the decision tool aims to maintain higher levels of AIP grant eligibility at EAS airports. AIP grants are a necessity to fund safety management systems (SMSs) for airport operators, as outlined in FAA Advisory Circular 150/5200-37. If decisions about EAS funding are made without considered such effects on an airport's AIP eligibility, the ability of an airport to mitigate risks and maintain safety may be hindered.

Secondly, the decision tool incorporates FEMA disasters surrounding EAS airports into EAS policy decisions. As outlined in the FAA Safety Management System Manual, Safety Policy is the first step to Safety Risk Management. By identifying and analyzing hazards (in the form of FEMA disasters) around EAS airports, better judgement can be made about the required funding appropriations to EAS airports.

5 Conclusions

EAS program policy decisions need to be data driven to improve program efficacy, especially in the face of budget cuts. The designed multi-criteria decision tool allows a higher number of EAS program passengers to maintain access to EAS routes compared to previous single objective solutions.

The work here is only an example of using data to drive EAS policy decisions with criteria chosen by the research team. Actual implementation of the work would require utilizing aviation industry stakeholders to comprehensively study potential EAS decision criteria,

Finally, the higher level question of whether people are getting more out of the EAS program in spite of the higher program costs is yet to be answered. Doing so may justify keeping the EAS program costs at the current subsidy levels.

6 Interaction with Airport Operators and Industry Experts

6.1 Meetings with EAS Airport Stakeholders

On February 26th, 2014 the design team traveled to an airport receiving EAS service: Imperial County Airport (IPL) in the city of Imperial, CA. At IPL we met with the airport administrator, Elizabeth Moreno, as well as Community Affairs Manager of Seaport Airlines (the airline operating the EAS route) and mayor of Imperial, CA, Geoff Dale, to get their perspectives on the influence of EAS funds at IPL.

Figure 11. Meeting with Ms. Moreno at IPL airport.

From these interviews, our team's primary take-away message is that EAS is vital to the community, but there is little data to support the claimed benefits of EAS. Thus with little empirical evidence, decisions on EAS's future were speculative rather than data driven. The result of these interactions was an understanding that at the minimum, data for 1) other government subsidies, 2) freight/mail data, 3) accessibility (which the team later defined as road density) would have to be applied in some manner to better capture the effects of EAS. Only after capturing the effects of EAS through data can data driven decisions be made.

Highlights of the meeting included 1) EAS funding is essential in maintaining eligibility for other government grants, such as AIP, 2) government grants are vital in the upkeep of IPL airport, especially to accommodate military and freight/mail use at IPL airport, 3) EAS airports play a significant role to the local community, such as providing citizens access to the greater transportation network. Since there can be no guarantee for future EAS funding, EAS airlines are taking proactive steps to ensure their market sustainability through easier access for travelers. The following is a recap of the meetings as well as a conclusions of EAS effects on IPL airport and the local community.

6.1.1 Airport Administration

EAS airports are utilized for other services beyond scheduled air service. For example, IPL airport is also heavily utilized for military, cargo, and agriculture operations. Although IPL is a civilian airport, it is often used by military to handle capacity overflow from neighboring military airfields. Examples of such military operations include dialing landings of six V-22 Ospreys, the occasional use by the Blue Angels, and the landing of C-130s to carry British RAF paratroopers to nearby jump sites. Additionally, UPS, FedEx, and PCM operate several cargo flights daily from IPL and one crop dusting company is based at IPL with two aircraft servicing the nearby farms.

IPL airport, fixed base operators (FBOs), and the city of Imperial earn revenue from military, cargo, and agriculture operations through landing fees, fuel sales, and rental of terminal space. First, landing fees are paid to IPL airport, e.g. $130 for a landing by a C-130 (roughly $1/1,000lbs based on the C-130's max. normal landing weight of 130,000lbs). This higher fee, relative to other operations at IPL, was cited by airport administration as necessary to offset the impacts of additional runway wear and tear due to the C-130's weight. Secondly, FBOs are able to sell fuel to aircrafts, which is a considerable amount considering that a C-130 is able to hold over 9,000 U.S. gallons. At a 2014 market price of roughly $6/gal, fuel sales could well exceed $50,000 per refueling.

Additionally, the presence of a commercial air service at the airport leads to the occupation of commercial rentals in the terminal building operated by the city of Imperial. The EAS airline accounts for half the rental space occupied, while the remaining space is filled with supporting businesses such as rental car companies.

Finally, it was cited that a <u>main source of funding for airport operations are grants, such as AIP</u>, from the federal government. Federal grants pay for maintenances such as the inspection of runways and lights, while money from Imperial County pay administrative salaries to the workers. A reduction of federal grants was cited as a hindrance to the ability of IPL airport to keep the current level of maintenance at the airport. Thus, without an upkeep of the runways and facilities, IPL risks losing the current relationship with military, cargo, agriculture, and general aviation to competitors that would be able to provide minimum facilities.

Although AIP grants are paid directly to the airport, the fact that AIP is judged based on passenger enplanement means that airport funding (and jobs) is still reliant on EAS service. Maintaining and creating jobs for Imperial, CA was cited by Mayor Geoff Dale as particularly important to his community which fights an exceptionally high unemployment rate of 30% at its worst, and still currently hovers around 20% in 2014 (Bureau of Labor Statistics, 2014).

6.2 Airline Operator and Mayor of Imperial, CA

The discussion with Mayor Dale, who also serves as Seaport Airline's Community Affairs Manager, provided significant insight into an EAS airline's strategy in succeeding. This strategy composed first of scheduling flights from IPL airport so that passengers flying Seaport could connect to other flights, at San Diego and Burbank airport. Ensuring that flights departing IPL airport could connect to a high number of flights at the larger airports were crucial to garnering public interest in the EAS service.

Mayor Dale cited that these routes were particularly important for politicians, such as himself, and businessmen to have access to meetings in Sacramento, the state capital. Prior to EAS flights being timed to enable ongoing connections, politicians traveling to the state capital were forced to spend a night in transit, resulting in accommodation and per diem costs billed to the city as well as lost time away from the office.

Secondly, choosing an aircraft to fit the market was essential in Seaport Airline's strategy. In the case of IPL airport, Seaport Airlines chose to operate a 9 seat Cessna Caravan 208 compared to the former EAS operator, Skywest, who chose to operate the 30 seat Embraer EMB-120ER. Compared to the heavier Embraer, operating the smaller Caravan 208 allows Seaport Airlines to lower overhead operational costs while operating several daily round trips to hub airports.

Thirdly, ensuring travelers are able to easily purchase tickets and connections are part of Seaport Airlines' strategy towards long term market sustainability. In order to achieve this step, in April 2014 Seaport Airlines joined Amadeus Altea reservation management system (SeaPort

Airlines, 2014) which allows travelers to purchase flights from/to IPL airport and connections on the same itinerary. Seaport Airlines is one of the first EAS supported airlines (that is independent of larger carriers) to be included in this reservation management system. Resultantly, travelers are now able to connect to/from the EAS airport through mainstream reservation systems such as through Kayak internet search. Previously, flights for Seaport Airlines had to be purchased directly through Seaport Airlines' website. Although the incorporation of Seaport Airlines is anticipated to increase traveler accessibility to flying EAS routes, future data of the Seaport Airlines performance will be needed to determine their success.

6.3 Interaction with Industry Experts

6.3.1 Applying the Design to Australia

The development of this analysis and decision tool for remote airport subsidies has led to interactions Australian Airports Association's (AAA) Regional Airports Officer, Jared Feehely, and CEO, Caroline Wilkie.

Australia, similar to the US, has populations separated by vast distances resulting in communities that depend on government subsidies to maintain scheduled air service. Also similar to the US, the Australian federal government is debating funding cutbacks to their Remote Aviation Access Program (RAAP), a subsidy similar to EAS.

The AAA has been in contact about gaining supporting data for the continued funding of the RAAP program. <u>This interaction with industry experts abroad has demanded that the developed decision and analysis tool be robust enough to apply to other aviation systems.</u> The broader application and validity of the design tool will be tested in Australia from September 2015 to March 2016, with funding supported by Australia's Department of Education.

6.3.2 Presentation at 9th NASPS

Domestically, the work has been invited to be presented at the 9th National Aviation System Planning Symposium (NASPS) in both a chaired talk as well as poster session in May 2015. As this research is ongoing and continually iterative, feedback from airport stakeholders and transportation policy makers are continually used to validate and improve the decision tool.

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Appendix B: Description of Purdue University

Purdue University is located in West Lafayette, Indiana and was founded upon a donation from John Purdue in 1869 to establish a college of science, technology and agriculture. The first classes were held in September of 1874 with a total of 36 students. Today, Purdue is home to 29,555 undergraduate students, 9,215 graduate students, and 3,055 faculty members. This student body participates in over 200 undergraduate majors ranging from mechanical and biomedical engineering to agronomy and turf sciences; and the Graduate School offers more than 70 masters and doctorate programs. In addition to the large variety of academic programs, Purdue is world-class in diversity, offering up the fourth largest international student population in the United States.

The School of Industrial Engineering (IE) at Purdue University has a rich history of innovation throughout the 20th century. In 1935, Lillian Gilbreth became the first female engineering faculty member at Purdue, and along with her husband Frank, went on to become pioneers in motion study and human factors. Their contributions to the field of IE created a rich environment for talented faculty members and in 1955, the School of Industrial Engineering and Management was officially founded at Purdue. Through the 1960's and 1970's, academic greats such as Alan Pritsker and James Solberg led the program through a time of innovation and growth with major contributions in simulation and intelligent manufacturing systems, and by the 1990's, Purdue IE was ranked as the second best collegiate IE program in the nation.

Today, the Industrial Engineering program at Purdue continues the legacy of its ancestors to break new ground in human factors, operations research, and supply chain and systems engineering for healthcare, transportation, and manufacturing.

Appendix C: Description of non-University Partners

Imperial County Airport

Imperial County Airport is an EAS airport located in Imperial, California, and is a county-owned public use airport. The airport serves general aviation, military, air-taxis and first began scheduled commercial service in the 1950's with Bonanza Airline. Since 1953, a variety of small-aircraft commercial service flights have been operating out of Imperial County Airport to destinations such as San Diego, Burbank, Van Nuys, Los Angeles, and occasionally Phoenix, Arizona. By early 2007, SkyWest was operating out of Imperial County Airport as a United Express commercial flight route, but as of 2014, SeaPort Airlines has taken over as the single commercial airliner with service to and from Imperial County Airport.

Australian Airports Association

The Australian Airports Association (AAA) is a not-for-profit organization which, founded in 1982, provides an advocate voice for small airports all over Australia. The AAA often provides support for smaller airports and aerodromes in government dealings, and works to opportunities for these airports to grow and develop their operations over time. The AAA represents more than 260 airports throughout Australia and works with more than 100 different corporate aviation stakeholders throughout the country to provide goods and services to the airport industry.

Appendix E: Evaluation of Educational Experience

Students

1. The ACRP Design Competition did provide a meaningful experience for our team by putting us in contact with aviation stakeholders in the US, as well as facilitating future collaboration abroad. By interacting with domestic airport and airline operators, we were able to understand the needs and uses of small communities airport beyond what is outlined in research papers, textbooks, and government documents. Through interacting with international airport agencies, we learned of the global problems facing air transportation to small communities that pushed for an element flexibility into the design of our decision tool so it can be adapted to other aviation systems.
2. The first challenge our team encountered was deciding upon the criteria to judge an airport's necessity for EAS funding. EAS subsidies can facilitate an innumerable amount of benefits and it's impossible to consider all of them. For example, one industry official brought up the point that a benefit of maintaining air service to regional airports facilitates training for new pilots before they move to more heavily traveled routes. To account for benefits such as this, our team decided that our design should not be a steadfast set of criteria of which to judge EAS, but rather a flexible methodological framework that industry experts can use to decide on EAS funding.

   A second challenge we encountered was getting in touch with airport and airline officials. Although aviation stakeholders were enthused to work with us in our research and design via email communications, the matter was understandably not so pressing from their perspective. This challenge was addressed by showing up to the nearest EAS airport and asking for in person meetings.

A third challenge our team faced was learning to use ArcGIS software to extract data from US government sources. Learning ArcGIS required several weeks of tutorials and practice to become acquainted with geospatial analysis techniques and the Python programming language in order to access the relevant data.

3. Our team developed our hypothesis, that EAS funding decisions would be better guided if based on data, through a comprehensive literature review of the research and debates surrounding EAS policy. A common theme in arguments of both EAS supporters and critics was a lack of empirical data. Decisions about EAS may not (and perhaps should not) be based on data alone. There is also a philosophical component to the debate that this research does not encompass, e.g. do citizens have the right to scheduled air service in the same way they have the right to postal service? However, the team saw no disadvantage in providing a base of empirical knowledge that could be accessed for future EAS decisions.
4. The participation by industry was useful to learn about airport uses and needs that are not often highlighted in literature. For example, meeting with the manager of Imperial County Airport highlighted that maintaining funding and upkeep at the airport is relevant not only to the passenger air service, but also to the freight/mail that pass through the airport as well as military aircraft that use Imperial County Airport's runways in times of training exercises with high traffic. Through these meetings with industry stakeholders, it became clear to the team that a wider set of decision criteria would be necessary for more robust decisions about the future of EAS funding.

Furthermore, communicating with Australian officials about their issues facing remote air transportation also emphasized the need for decision tool to have broad application.

5. Through this design project, <u>our team learned</u> valuable skills in applying data to capture the working mechanisms of aviation policy and support future decisions. <u>This skill will be helpful in the workforce</u> as aviation systems outside the US face a similar lacking of data to drive policy decisions. The project has already garnered interest and funding from Australian agencies to aid in their aviation policy decisions as well.

Faculty

1. The <u>value of the educational experience for Jao and Caitlin</u> was that it caused them to consider this work, which had been primarily academic, in terms of its practical application. Jao and Caitlin not only interacted with industry stakeholders in a meaningful way, to obtain an understanding of this subsidy program on operations, but also had to then explain the work in terms of its practical application. This aspect can often be overlooked in educational settings, where we often construct greatly simplified versions of problems in order to make solutions tractable and understandable. Having to thoroughly consider the work in a practical context results in a much deeper, and more meaningful, experience.

2. <u>The learning experience was appropriate to the course level</u> (Ph.D. research) in that the students identified the gap in knowledge themselves, identified a solution, executed that solution, and reported on the results. I would be briefed on the work occasionally, and would give advice on how to structure the work, or things that might need to be considered, but was otherwise mostly uninvolved in the actual work.

3. The students faced and overcame a number of problems. First, having to identify, contact, and obtain information from operational stakeholders is challenging, because these people are often busy, and frequently do not understand the problem in the same way that it is presented by the students. It requires some skill to listen to these stakeholders, understand what they are saying and why they are saying it, and then translating that into useful input/feedback for the project. Second, the students, like all Ph.D. students, face challenges in switching from being a "doer" of engineering/science, to be a "creator" of science. These students had to learn to identify a gap in knowledge/practice based on their understanding of the domain, and address it in an objective, scientific way in the absence of past practice with respect to the problem. This can be very challenging to many students. Lastly, the scope of this particular problem required an appreciation of, and knowledge in, many different disciplines, including at least engineering and political science. These students had to integrate knowledge from these diverse fields to be able to present a solution that was acceptable to persons of at least both of these fields.

4. I would certainly use this competition as an educational vehicle in the future. I have recommended teams use this competition in the past, and have encouraged my own students to submit to this competition. I feel it provides them not only with a practical framework in which to consider their work, but also provides them with excellent external feedback that they would otherwise not obtain. Students often lack strong motivation to put their top effort into simple semester or year-long projects for a grade; this requires them

to consider an external evaluation, which results in a higher level of effort and more attention to detail.

5. I have no recommendations for changes to the competition in future years. I have been working with the competition for many years, and over that time have made a number of suggestions, but feel the competition has found a great niche, and do not recommend any expansions, contractions, or alterations to the challenge areas or procedures.

Appendix F: References

Adler, N., Ülkü, T., & Yazhemsky, E. (2013). Small regional airport sustainability: Lessons from benchmarking. *Journal of Air Transport Management, 33*(0), 22-31. doi: http://dx.doi.org/10.1016/j.jairtraman.2013.06.007

AIP Grant Histories. (2013). Retrieved October 21, 2013, from http://www.faa.gov/airports/aip/grant_histories/

Bråthen, S., & Halpern, N. (2012). Air transport service provision and management strategies to improve the economic benefits for remote regions. *Research in Transportation Business & Management, 4*(0), 3-12. doi: http://dx.doi.org/10.1016/j.rtbm.2012.06.003

BTS Air Traffic Data. (2012). 2013, from http://www.transtats.bts.gov/airports.asp

Bureau of Labor Statistics. (2014). El Centro, CA Metropolitian Statistical Area. *Databases, Tables & Calculators by Subject.* Retrieved July 29, 2014, from http://data.bls.gov/timeseries/LAUMT062094000000003?data_tool=XGtable

Bureau of Transportation Statistics. (2014). *Subsidized Essential Air Services Communities and Distances to Nearest Hubs*. Retrieved from http://www.dot.gov/sites/dot.gov/files/docs/EAS%20community-distances%20to%20nearest%20hubs-Apr%202014.pdf.

Census Data. (2010). Retrieved April 23, 2013, from http://mcdc.missouri.edu/websas/caps10c.html

Congressional Record 113th Congress (2013-2014): July 30, 2013. (2013). Retrieved December 16, 2013, from http://thomas.loc.gov/cgi-bin/query/B?r113:@FIELD%28FLD003+d%29+@FIELD%28DDATE+20130730%29

Donehue, P., & Baker, D. (2012). Remote, rural, and regional airports in Australia. *Transport Policy, 24*(0), 232-239. doi: http://dx.doi.org/10.1016/j.tranpol.2012.08.007

Essential Air Service. (2013). Retrieved February 07, 2013, from http://www.dot.gov/policy/aviation-policy/small-community-rural-air-service/essential-air-service

FEMA. (2015). FEMA GIS Data Feeds. Retrieved April 1, 2015, from http://gis.fema.gov/DataFeeds.html

Grubesic, T., Wei, R., Murray, A., & Wei, F. (2014). Essential Air Service in the United States: Exploring Strategies to Enhance Spatial and Operational Efficiencies. *International Regional Science Review*.

Grubesic, T. H., & Matisziw, T. C. (2011). A spatial analysis of air transport access and the essential air service program in the United States. *Journal of Transport Geography, 19*(1), 93-105. doi: DOI 10.1016/j.jtrangeo.2009.12.006

Grubesic, T. H., Matisziw, T. C., & Murray, A. T. (2012). Assessing geographic coverage of the essential air service program. *Socio-Economic Planning Sciences, 46*(2), 124-135. doi: http://dx.doi.org/10.1016/j.seps.2011.12.002

Grubesic, T. H., Murray, A. T., & Matisziw, T. C. (2013). A strategic approach for improving rural air transport in the United States. *Transport Policy, 30*(0), 117-124. doi: http://dx.doi.org/10.1016/j.tranpol.2013.09.004

Grubesic, T. H., & Wei, F. (2013). Essential Air Service: a local, geographic market perspective. *Journal of Transport Geography*, *30*(0), 17-25. doi: http://dx.doi.org/10.1016/j.jtrangeo.2013.02.008

Lian, J. I., & Rønnevik, J. (2011). Airport competition – Regional airports losing ground to main airports. *Journal of Transport Geography, 19*(1), 85-92. doi: http://dx.doi.org/10.1016/j.jtrangeo.2009.12.004

Matisziw, T. C., Lee, C.-L., & Grubesic, T. H. (2012). An analysis of essential air service structure and performance. *Journal of Air Transport Management*, *18*(1), 5-11. doi: http://dx.doi.org/10.1016/j.jairtraman.2011.05.002

McClintock, T. (2013). Essential Air Service. Retrieved December 16, 2013, from http://mcclintock.house.gov/2013/07/essential-air-service-2.shtml

Missouri Census Data Center. (2015). Retrieved April 01, 2015, from http://mcdc.missouri.edu/

Non-Alaska U.S. Carrier Subsidy Reports. (2012). *Essential Air Service Reports.* Retrieved February 07, 2013, from http://www.dot.gov/office-policy/aviation-policy/essential-air-service-reports

Non-Alaska U.S. Carrier Subsidy Reports. (2015). *Essential Air Service Reports.* Retrieved April 22, 2015, from http://www.dot.gov/sites/dot.gov/files/docs/Subsidized%20EAS%20report%20for%20non-Alaska%20communities-April%202015_1.pdf

Özcan, İ. Ç. (2014). A community evaluation of Essential Air Services. *Journal of Air Transport Management*, *36*(0), 110-119. doi: http://dx.doi.org/10.1016/j.jairtraman.2013.12.005

Pita, J. P., Antunes, A. P., Barnhart, C., & de Menezes, A. G. (2013). Setting public service obligations in low-demand air transportation networks: Application to the Azores. *Transportation Research Part A: Policy and Practice*, *54*(0), 35-48. doi: http://dx.doi.org/10.1016/j.tra.2013.07.003

Schaper, D. (2011). FAA Debate Puts Subsidized Rural Airprots At Risk. Retrieved December 16, 2013, from http://www.npr.org/2011/08/01/138901060/faa-debate-puts-subsidized-rural-airports-at-risk

SeaPort Airlines. (2014). SeaPort Airlines Completes Cutover To Amadeus Altea Technology Platform.

Smith, J. (2010). Regional Cooperation, Coordination, and Communication Between Airports During Disasters. *Transportation Research Record: Journal of the Transportation Research Board*, *2177*(-1), 132-140. doi: 10.3141/2177-16

Smith, J. (2014). Effective Cooperation Among Airports and Local and Regional Emergency Management Agencies for Disaster Preparedness and Response *ACRP Synthesis* (Vol. 50). Washington, D.C.: Transportation Reserach Board.

Usami, M., & Akai, N. (2012). Financial performance of airport terminal companies in Japan – Harmful effects of government participation. *Journal of Air Transport Management, 25*, 40-43. doi: 10.1016/j.jairtraman.2012.07.001

Wittman, M. D., & Swelbar, W. S. (2013a). Modelings Changes in Connectivity at U.S. Airports: A Small Community Perspective *MIT Small Community Air Services White Paper*: Massachusetts Institute of Technology's International Center for Air Transportation.

Wittman, M. D., & Swelbar, W. S. (2013c). Trends and Market Forces Shaping Small Community Air Services in the United States *MIT Small Community Air Services White Paper*: Massachusetts Institute of Technology's International Center for Air Transportation.