Growing an Airport:
Creating More Connections to the North-Mid Western United States

Erica Hall

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Table of Contents

Table of Figures

Introduction

There are over 13,000 airports across the United States; however, only about 11% are accessible to the traveling public. Figure 1 displays what the traveling population is most familiar with: primary airports, or, "commercially serviced airports the Secretary of Transportation determines to have more than 10,000 passenger enplanements each year" (49 U.S. Code §47102(16)). Commercially serviced airports are all publicly owned, have at least 2,500 yearly enplanements, and have scheduled air carrier service. Primary airports are categorized into four subcategories that correspond with their yearly enplanements. These categories include large hubs, medium hubs, small hubs, and non-hubs. Although primary airports of all sizes are found across the United States, there are still a few smaller primary airports that are harder to access. These smaller airports tend to be located in more rural regions of the country and can be very far to travel to, making some travelers go to a different state in order to fly. Additionally, smaller primary airports are typically more expensive to fly out of compared to the larger hubs. Unfortunately for some, the small airports or driving several hours is their only option.

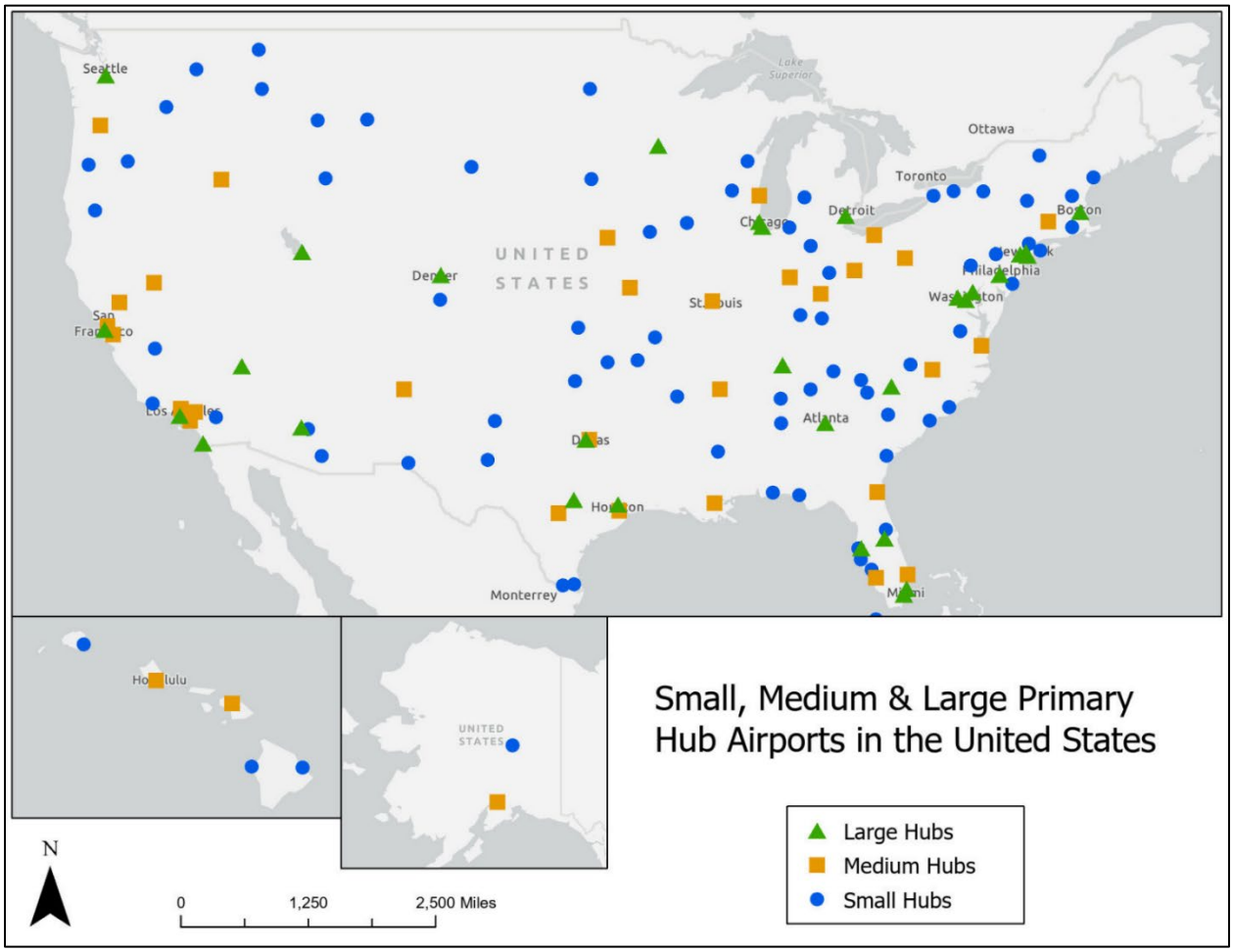

Figure 1: Small, Medium, and Large Primary Hub Airports in the United States.

This capstone project focuses primarily on small hub primary airports, “commercially serviced airports that [have] at least .05 percent and no more than 0.25 percent of passenger enplanements,” located in the North-Mid Western region of the country (49 U.S. Code §47102(25)). Within this region, there are ten small hub airports. Figure 2 shows the location of each of those airports that have been analyzed. These airports are isolated away from other airports with only two large and two medium hub airports within a 200-mile buffer of this study area. Figure 3 shows that large hubs Seattle-Tacoma International and Minneapolis-St. Paul International airports and medium hubs Portland International and Eppley Airfield, NE are within the 200-mile buffer.

This region of the U.S. is home to some of the most visited National Parks in the country, including Yellowstone, the Badlands, Grand Teton, the North Cascades and more. In 2023, there were over 17.8 million visitors to the National Parks in this region alone (National Parks Service, 2023). In addition to the Parks, this region is also home to several National Monuments, Historical Sites and Parks, Preserves, and recreational areas. Figure 4 shows the location of these Parks and Monuments within the North-Mid Western region of the country. Allowing these Parks to be more accessible to visitors is key to not only continue increasing the number of yearly visitors, but also making the preservation of the lands possible from the collected funds.

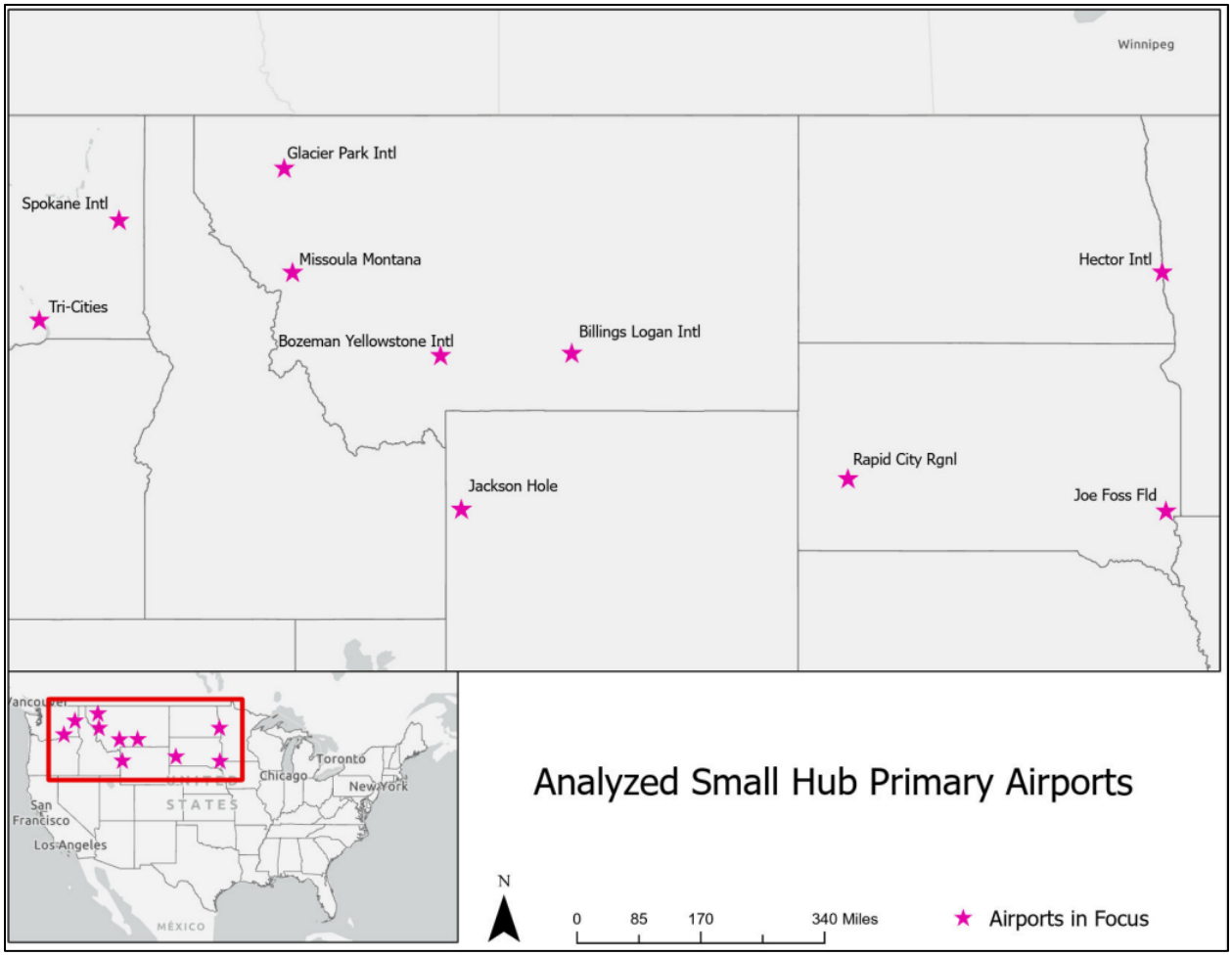

Figure 2: Ten analyzed small primary hub airports.

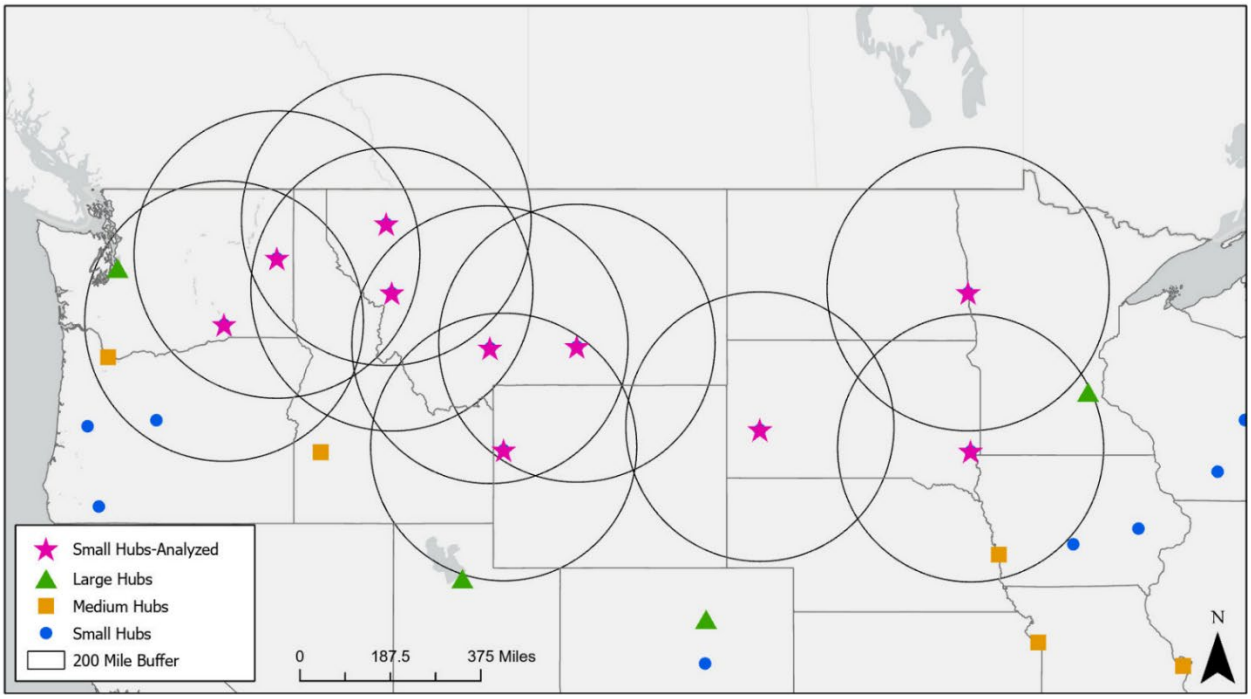

Figure 3: 200-mile buffer around the analyzed airports. Only four larger airports within this buffer.

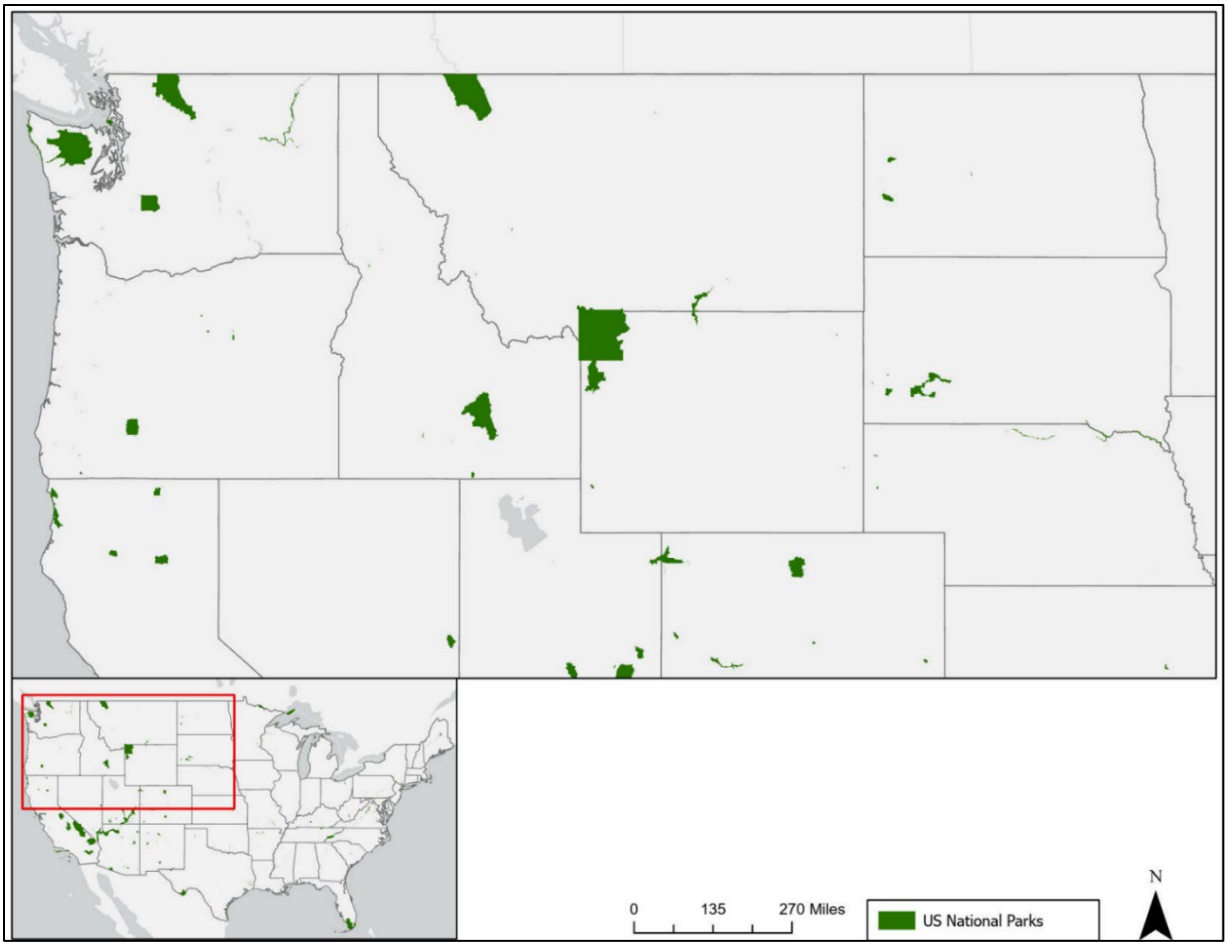

Figure 4: Locations of National Parks, Monuments, Historical Sites & Parks in the Mid-to Northwestern region of the U.S.

Having a larger airport would provide increasing value to this region of the U.S. The region would see an increase in daily and weekly direct flights from more destinations across the country, which would also help to reduce airfares to the airport. Travelers visiting the National Parks would have the option to have a connecting flight to one of the smaller local airports or drive to their destination from the larger airport. Providing travelers the option to fly rather than driving multiple hours to other states is a crucial benefit. Additionally, the increase of accessibility to this region will, in turn, increase the economic potential for both the National Parks and local cities and towns. The goal of this study is to identify which of the ten selected small hub airports would be best suited to be expanded into a medium to large hub airport.

Literature Review

The North-Mid Western region of the US is vast with very few heavily populated cities and a lot of natural beauty. With states that have a larger area and a more spread-out population, travelers drive several hours in order to reach their closest medium or large hub airport. The smaller hub airports in the region do not provide the number of flights or a price point that is suitable for all travelers, pushing them to drive farther to a larger airport. Both Lieshout (2012) and Yirgu et al. (2023) agree that travelers are attracted to large hub airports and are willing to drive two or more hours for the number of services made available including flight frequency and offered destinations. When a large hub can offer services

that smaller hubs cannot, its catchment area increases, meaning travelers will drive the two or more hours to get to the airport. Both articles suggest that if small hub airports grow their flights to include more short and medium distance routes, their catchment areas will also increase, and travelers will not have to drive as far to reach the airport. Furthermore, as more people use the smaller to medium sized hub airports, they will attract more travelers, creating a positive synergy between the two (Fu et al., 2016). All three authors argue that the goal of having smaller airports is to access the different regions across the country. Therefore, it is important to increase the number of fights to these smaller airports. These areas will become more accessible, and travelers will not need to drive farther into other states to board their flights.

Tourism is a large reason why travelers fly. Travelers choose their destination airports based on the attractions that are close by. With airlines bringing travelers from all over the country, the airports make a significant impact on the local economy. Blonigan et al. (2015) and Florido-Benitez (2023) both agree that the location of the airport impacts the local economy. If an airport is near a major metropolitan center with available transportation between the city and airport, the airport will bring in tourists, goods, and other services to the area. However, if the airport is located away from a major city with limited accessibility, it provides little to no support for the economy. That said, both authors support the idea of increased infrastructure connecting people to the airport, as well as increasing the connectivity among airports. This increase in connectivity will boost the number of travelers that will use and go through a smaller airport. There is also a positive correlation between the number of enplaned passengers and the increase of employment for the surrounding metropolitan statistical area.

Diving deeper into the tourism aspect of flying is identifying the locations and attractions travelers are going to see. Some of the country's more unique National Parks are located in the Midwest. For example, Yellowstone, the Grand Tetons, the Badlands, and Glacier National Park are all found in this region of the U.S. In 2023, this region of National Parks saw over 17 million visitors (National Parks, 2023). However, despite the high numbers of visitors and the uniqueness of each park, they are unfortunately harder for visitors to travel to. Lu et al. (2023) argues that "there is a lower participation of populations with limited access to socioeconomic resources such as income, education, and transportation" visiting National Parks and that "95% of visitors were white." Additionally, "many of the parks are located in more rural and remote places, increasing the cost of transportation costs" (Lu et al. 2023). With the expansion of one of the regions local airports, along with increased destinations and the requirement to be close to a National Park, these marginalized groups will have a better opportunity to visit one or many of these parks. The National Parks bases its existence on accessibility to all visitors, and by expanding air travel to further regions of the country, more diverse populations will be able to visit.

The price of airfare is a big determinant when deciding which airport to use. Typically, larger airports tend to have less expensive airfares compared to small and medium airports. Authors Lutamann (2019) and Ivaldi et al. (2015) suggest that there is more that goes into airfare pricing than the size and location of an airport. For example, prices may be set by airlines based on several factors including the congestion of the airport, demand for the destinations, services provided at the airport for passengers, and non-aeronautical fees. Low-cost carriers (LCCs) may also be an answer to this airfare problem for small and medium hub airports. LCCs are defined as "airlines that are operated to minimize operating costs and without the conventional in-flight services and amenities" (LOH et al., 2020). LOH et al. defines the criteria that LCCs are looking for in a potential airport. Some of the main criteria include the airport's catchment area, the airport's infrastructure, and growth opportunities, all of which an expanding and growing airport would have. With more airlines flying into your airport, especially lower cost airlines, more travelers will choose to fly out of the airport.

To complete this capstone project, a Suitability Analysis or Multicriteria Decision Making (MCDM) analysis has been used. This method potentially "combines unrelated data in a meaningful manner" by assigning weights to the criteria dependent on their relative importance to the project goal (Janke, 2010). Both Janke (2010) and Wanore et al. (2023) agree that using a MCDM analysis with a geospatial case study is a valuable technique that analyzes multiple layers of criteria and adds the extra layer of location in order to find the most suitable option. Additionally, running this analysis in GIS provides suitability scores which are based on the weighted criteria. These scores provide a ranking of the areas that are the most to least suitable. Both authors, Jenke (2010) and Wanore et al. (2023) emphasize the importance of visually displaying the data by including several static maps throughout their methodology. These maps not only reflect the location of their respective studies, but also show each individual criterion in the area before they are layered together for the final suitable location. These maps are providing the additional details needed to complete their study and augment the readers' understanding of the case study in its entirety.

Data

The data needed for this capstone project will be used to define the criteria for the analysis. An Excel spreadsheet from the National Plan of Integrated Airport Systems (NPIAS) (FAA, 2022) with all of the airports and a shapefile including all of the airports throughout the U.S. (FAA, 2016) will be used to show the locations of the airports and describe pertinent information such as role, hub status, enplanement, etc. Figure 5 shows the number of enplanements per airport from 2023. A runway shapefile, also retrieved from the FAA's open database (2024), provides additional information for the airports and will be used as one of the criteria for the analysis. The runway data includes the length of each runway at every airport and will be used to identify which airports are capable of landing a standard Boeing 737, the most commonly used aircraft for commercial flights in the US. Data about each selected airport such as the number of destination hubs, the number of commercial airlines that service each airport, and whether the airport services international flights or not will be collected from FlightsFrom.com (2024). All data collected from this source will be based only on commercial airlines servicing the small primary hub airports.

Figure 5: Number of enplanements per analyzed airport as of 2023.

Population data from the U.S. Census Bureau is collected from the five states where the selected airports are located: Montana, North Dakota, South Dakota, Washington, and Wyoming (2020). Additional population data from neighboring states was also collected. The states included are: Oregon, Idaho, Utah, Nebraska, Iowa, and Minnesota. This data will be used to get a generalized number of potential travelers for each airport within a 150-mile buffer or a two-and a half hour driving boundary. Since the buffers cross many state borders, it is important to include the neighboring states. The population data will be displayed by census tract, displaying the population density within the driving boundaries. For this project, only total population data will be used to have a generalized idea of potential air travelers. All population data will come from the 2020 Census count. The surrounding road infrastructure will help to define the airport's expansion eligibility and how quickly travelers are able to get to a major highway. Figure 6 shows the interstates that run through the region in focus and how the routes flow in relation to the analyzed airport's locations. Interstate highway data is collected from Transportation.gov (2024). The final piece of data that will be used is the entrance points to nearby National Parks. This data will categorize the airports based on their distance from the National Parks entrances. Using the parks entrances will give a more accurate representation of the distances from the airports rather than using the general boundary of the entire National Park.

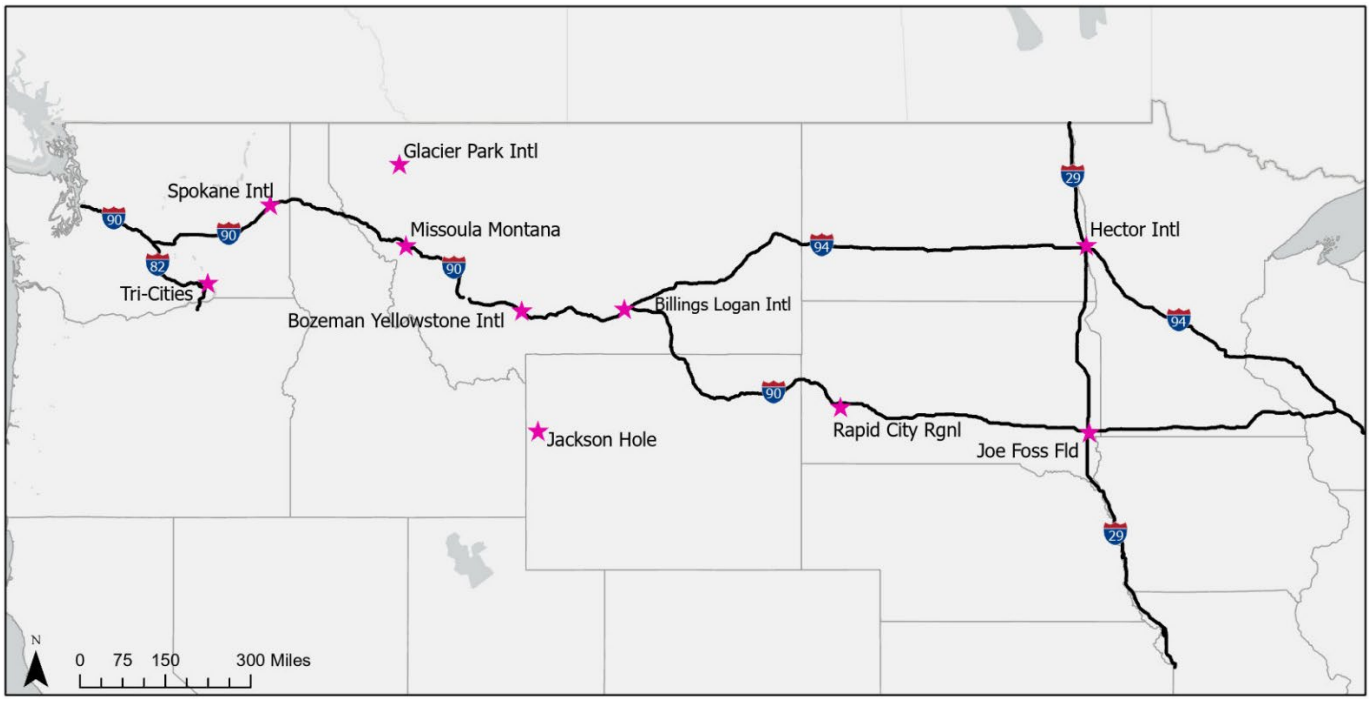

Figure 6: Interstate highways throughout the region in focus.

Methodology

For this capstone project, the data being used for the eight different criteria needed to be cleaned up before it can be included in the Suitability Analysis. One edit that occurred for all criteria was adding an extra column to the attribute table. Figure 7 shows the added columns holding the score each airport receives for the different criteria. These scores were used in the final analysis to determine the most suitable airport. The airports' shapefile was joined with airports Excel spreadsheet to identify all small, medium, and large primary hub airports. A new shapefile was created with the ten selected small primary hub airports that will be analyzed. The yearly enplanement data was included with the airports Excel spreadsheet and required no additional cleaning.

Small Hubs-Analyzed

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	Airport	City	STATE	Enplaned	Runway	Destination	Commercial Air	International	Population	Interstate	National Park
1	Billings Logan International	Billings	MT	379300	1	10	6	0	310288	2	2
2	Bozeman Yellowstone International	Bozeman	MT	973715	1	25	9	1	467110	1	2
3	Glacier Park International	Kalispell	MT	418094	1	16	7	1	370364	0	4
4	Hector International	Fargo	ND	408477	1	11	5	1	660652	2	0
5	Jackson Hole	Jackson	WY	497548	0	12	4	0	378952	0	4
6	Joe Foss Field	Sioux Falls	SD	501423	2	17	5	1	698141	3	0
7	Missoula Montana	Missoula	MT	384925	1	15	7	0	365908	1	1
8	Rapid City Regional	Rapid City	SD	337788	1	9	5	0	229255	2	4
9	Spokane International	Spokane	WA	1586110	2	19	7	1	1222126	1	1
10	Tri-Cities	Pasco	WA	347438	2	10	6	0	1365528	2	1

Figure 7: Attribute table for the Airports feature layer with added columns of criteria data.

The runway shapefile was narrowed down with a select by location, selecting only the runways associated with the selected airports. The length of each runway was compared against the average runway length requirement of a Boeing 737 which is 8,000 feet. Runways that were below 8,000 feet were noted with an “N” for no or “Y” for yes. In the airport’s attribute table, a column for runways was added. The total number of runways that met the length requirement for each airport was added for each airport.

The number of domestic destination hubs was counted for each selected airport as well as the number of commercial airlines servicing each airport. Figure 8 shows an example of the direct destination hubs from Rapid City Regional airport. The higher the count for each airport hub and commercial airline criteria, the better suited that airport is. Two columns were added to the airports attribute table, one for destination hubs and the other for airlines. The total number of destinations and airline services was added for each of the airports.

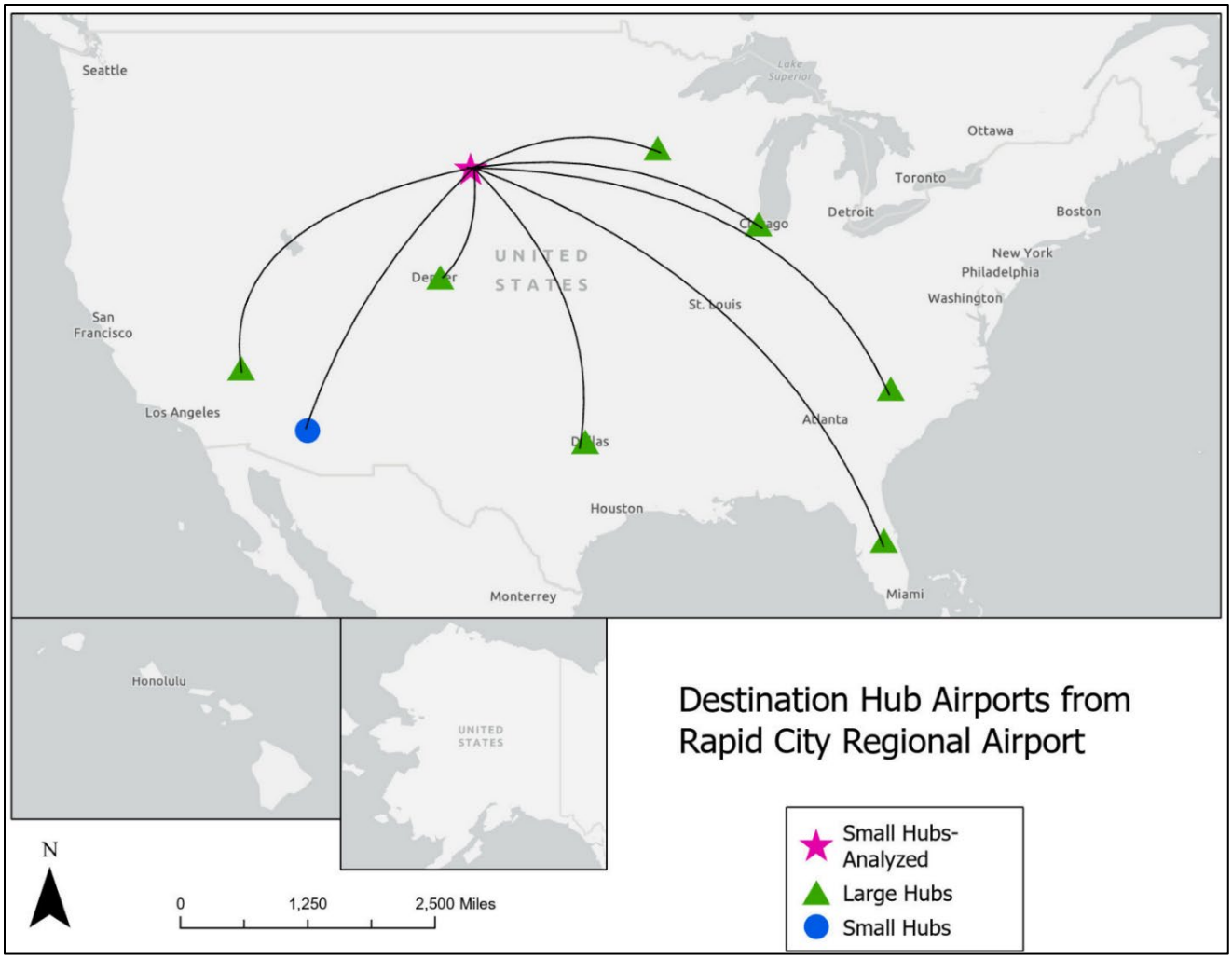

Figure 8: Direct flight destinations from Rapid City Regional, SD.

The international status of each airport was added as the fourth column to the airports attribute table. Airports that had U.S. Customs in any capacity (on standby, call to make an appointment, etc.) received a score of "1," noting that U.S. Customs is available. Airports that were not international, or did not have U.S. Customs available, received a score of "0."

To create a generalized catchment area for each airport, the two-and-a half hour driving determinant will be converted into the average number of miles that can be driven in that time frame. At an average speed of 60 MPH, approximately 150 miles can be driven in two-and-a half hours. Buffers of 150 miles were created around each airport, representing their generalized catchment area. The population data is displayed by their Census tracts to get a more accurate representation of where the population is living within the catchment areas. The population within each boundary was totaled, identifying the possible number of travelers for each airport. A new column ws added to the airports attribute table to hold the totaled populations for each airport.

To analyze the road infrastructure surrounding the airports, the number of miles from the airport to the nearest interstate highway was identified. A five-mile buffer was placed around each airport. The total

number of interstates within five miles of the airport was totaled and added as a new column to the airports attribute table.

National Parks were the last criterion added in the airports attribute table. Four buffers were added around each airport, 25 miles, 50 miles, 100 miles, and 200 miles, finding which airports were the closest to a National Park. As mentioned before, the entrance station for each park was used, determining the distance for travelers to access the Park from the airport. The buffer with the closest National Park to an airport corresponds to their score. The smaller the buffer, the higher the score, 25 miles receives a score of "4" and National Parks beyond 200 miles receives a score of "0." For example, Jackson Hole has an entrance station to Grand Teton within 25 miles and an entrance point to Yellowstone within 50 miles. Jackson Hole will receive a score of "4" based on the 25-mile buffer. Hector International receives a score of "0" for not having any National Parks within a 200-mile buffer.

Once the criteria have been cleaned and scored, they are ready to be entered into the Suitability Analysis. Using the Business Analyst toolbox licensing, there are four tools that are used to complete the Suitability Analysis. The airport's feature layer with attribute table is added to the "Make Suitability Analysis Layer," creating the feature layer that will be used for the analysis. The next tool used is "Add Field Based Suitability Criteria." After selecting the newly created Suitability Analysis layer, the eight criteria that are being used for the analysis are selected. Once run, this tool adds the criteria and associated data to the layer. The next tool used is "Setting the Criteria Properties". This is where the weight and influence of each criterion is set. All criteria weights should total up to 100 percent. For the initial analysis, all criteria were weighted equally at 12.5%. The influence for the criteria could be set as either positive, negative, or ideal. All criteria except the international status of the airports were set to a positive influence; the higher the criteria value, the higher the suitability score. The international status criterion was set as an ideal influence; the closer to the ideal value, the higher the suitability score. The ideal value chosen for the criterion was "1". This type of influence ensures that only those airports with international capabilities receive a score that increases their overall result, and airports without international capabilities receive a score of "0." Once all weights and influences have been set and are enabled to be included in the final score, the suitability analysis layer is ready to be calculated. This tool simply adds in the layer and runs the analysis, creating the final analysis results.

The analysis was run a second time, following the same steps as the original analysis and using the same eight criteria. The influence for each criterion also followed the same steps as the original analysis. However, the criterion was weighted differently for the second analysis. Having multiple runways is important to help reduce congestion on the air field, thus airports with two or more suitable runways have a heavier weight of 17. Connectivity from the airport to the local city or destination is another important factor when considering expanding an airport. The interstate criterion will have a higher weight of 17. Having connectivity to multiple destinations is very important, especially having those destinations already created. Airports with international flights, although not available every day, will be weighted at 17 since international flights are already established. Additionally, airport destinations were weighted at 17 due to the idea that an airport more flight destinations is appealing to travelers.

Since the overall population within the 150-mile catchment area is not the most accurate representation of the number of travelers that will use the airports, the weight was lowered to eight. Similarly, there are more reasons why travelers fly to and from these smaller airports; thus, the criterion of National Parks was ranked lower at eight. Although the number of enplanements and airlines per airport are good indicators of which airports are utilized more than others, both criteria are weighted lower at eight because they are not as representative in identifying which airport should be expanded as those criteria chosen to be weighted higher.

Results

Results from the analysis are different from what was initially expected. Early hypotheses believed that Billings Logan International in Montana would be a front runner due to its centrality to the region in the study and because it is an international airport. Additionally, Bozeman Yellowstone International in Montana was also thought to have a high ranking due to its proximity to Yellowstone National Park as well as being an international airport. After completing the first analysis, Spokane International in Washington ranked as the most suitable airport to be expanded into a larger airport. Bozeman Yellowstone International ranked as the second most suitable airport and Billings Logan International ranked eighth. Figure 9 displays the rankings and scores of all ten airports.

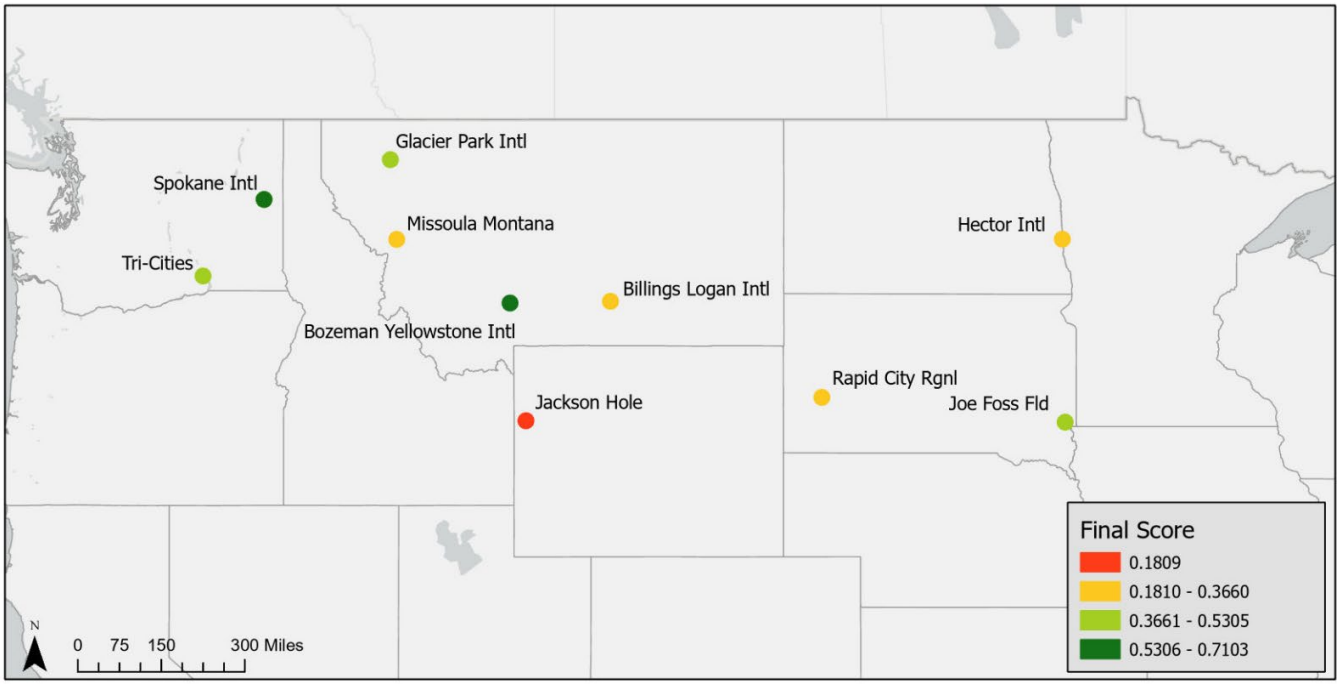

Figure 9: Final results of the first analysis, ranking the ten analyzed airports from least to most suitable.

Diving deeper, Figure 10 includes all of the results for each airport and criteria. All scores include the 12.5 equal weight. The top ranked airport, Spokane International, had a final score of 0.7103. This airport has scores for each of the eight criteria with number of enplanements, international status, and number of suitable runways having the highest scores of 0.1250. The lowest score for Spokane International was its distance to a National Park. The three parks are about 200 miles from the airport, resulting in a score of 0.0313. Spokane International also received a low score for number of accessible interstates within five miles of the airport. Only one interstate, I-90, is accessible to the airport, resulting in a score of 0.0417.

Bozeman Yellowstone International ranked second in the list but scored higher in different categories than Spokane International. This airport ranked highest in its distance to National Parks, with a score of 0.0625; the number of destinations the airport flies to; and the number of commercial airlines that service the airport, both with a score of 0.1250. Bozeman Yellowstone International scored the lowest for population at 0.0262 and access to interstates at 0.0417. This airport may have scored low on population, but it ranked high overall due to the number of tourists that visit Yellowstone National Park. These visitors are not included within the population data.

Jackson Hole was ranked the least suited out of the ten airports with a score of 0.1809. Unfortunately, the airport received a score of “0” for four out of the eight criteria. Jackson Hole’s highest scores were distance to a National Park at 0.1250 and number of destinations the airport flies to at 0.0234.

Additional results to note from the analysis include identifying that although Tri-Cities airport ranked fifth as the most suitable airport, it had the highest score for population, meaning it had the highest population within a 150-mile radius. Joe Foss Field. airport had the highest score for number of interstates within a 5-mile radius of the airport. The three airports that received the highest scores for National Parks all ranked fourth place and below. These airports are Glacier Park International, Rapid City Regional, and Jackson Hole, ranking fourth, seventh, and tenth respectively.

Airport	Destinations	Commercial Airlines	Enplanements	Population	Interstates	International	Runways	National Parks	Final Scores	Final Ranking
Billings Logan Intl.	0.0078	0.0500	0.0042	0.0089	0.0833	0.0000	0.0625	0.0625	0.2792	**8**
Bozeman Yellowstone Intl.	0.1250	0.1250	0.0637	0.0262	0.0417	0.1250	0.0625	0.0625	0.6315	**2**
Glacier Park Intl.	0.0547	0.0750	0.0080	0.0155	0.0000	0.1250	0.0625	0.1250	0.4658	**4**
Hector Intl.	0.0156	0.0250	0.0071	0.0475	0.0833	0.1250	0.0625	0.0000	0.3660	**6**
Jackson Hole	0.0234	0.0000	0.0160	0.0165	0.0000	0.0000	0.0000	0.1250	0.1809	**10**
Joe Foss Fld.	0.0625	0.0250	0.0164	0.0516	0.1250	0.1250	0.1250	0.0000	0.5305	**3**
Missoula Montana	0.0469	0.0750	0.0047	0.0150	0.0417	0.0000	0.0625	0.0313	0.2770	**9**
Rapid City Rgnl.	0.0000	0.0250	0.0000	0.0000	0.0833	0.0000	0.0625	0.1250	0.2958	**7**
Spokane Intl.	0.0781	0.0750	0.1250	0.1092	0.0417	0.1250	0.1250	0.0313	0.7103	**1**
Tri-Cities	0.0078	0.0500	0.0010	0.1250	0.0833	0.0000	0.1250	0.0313	0.4234	**5**

Figure 10: Table of the first analysis' results.

The results of the second analysis were only slightly different that those of the first analysis; Spokane International ranked first as the most suitable airport to be expanded into a larger airport and Bozeman Yellowstone International ranked second. Figure 11 displays the overall results for the second analysis. The main differences between the two analyses are that Hector International and Tri-Cities airport swapped their rankings. Hector International originally ranked sixth overall, moved up to fifth place after the second analysis. Tri-Cities airport originally ranked fifth, moved down to sixth place after the second analysis. The other eight airports all ranked at the same position in both analyses. In addition to most of the rankings remaining consistent across both analyses, the final scores of each airport were also very similar. Figure 12 shows the scores for each criterion per airport and the final score for each airport. These scores include the varied weights. The biggest difference in final scores was for Joe Foss Field airport. The first analysis gave the airport a final score of 0.5303 and the second analysis gave the airport a final score of 0.6545; a difference of 0.1242. This variance between analyses' is due to the larger difference in scores for the higher weighted criterion and a smaller difference in scores for the lower weighted criterion.

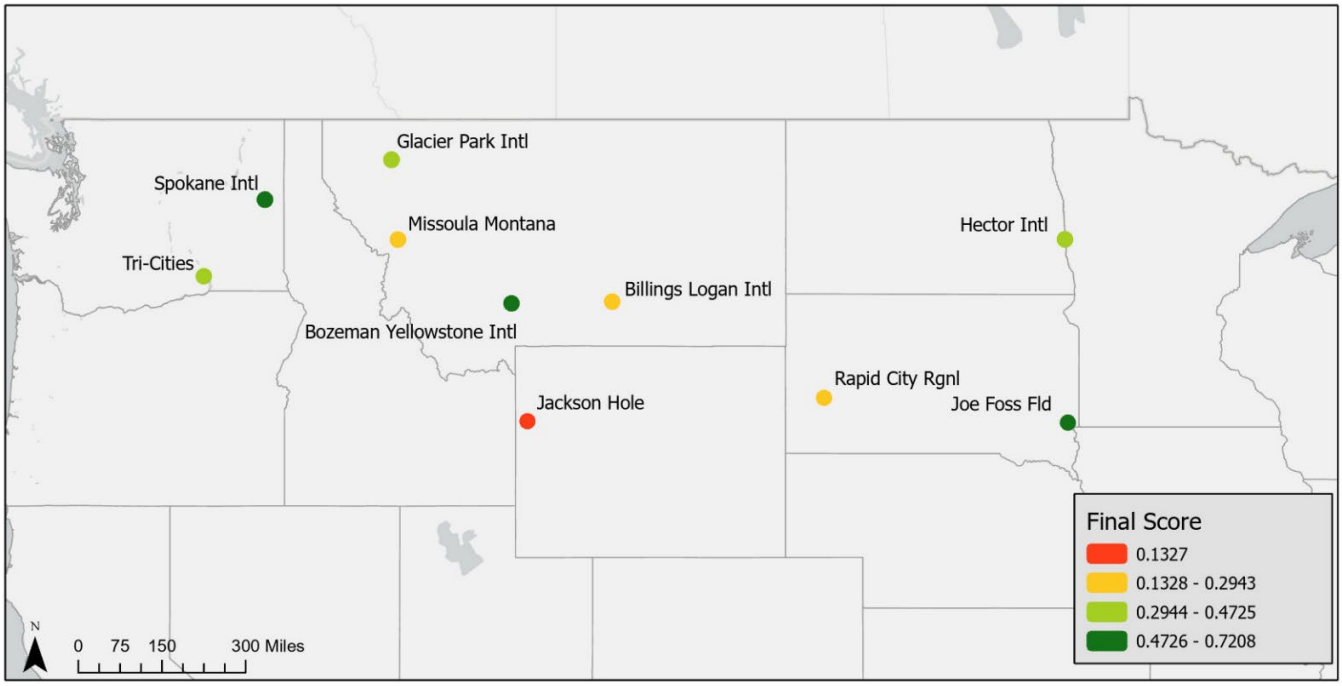

Figure 11: Final results of the second analysis, ranking the ten analyzed airports from least to most suitable.

Another major takeaway from running the analysis twice was that the top four airports remained the same; Spokane International, Bozeman Yellowstone International, Joe Foss Field, and Glacier Park International. Whether all the criteria were weighted equally or were varied, these four airports all hold some of the important qualities needed when looking to expand an airport. These airports either had or were very close to the maximum score in all criteria except for a few. Distance to National Parks and Interstates were two categories that the airports received lower scores in both analyses. This is particularly interesting because in the second analysis, interstates received a higher weight, leading to believe that the lower score would have more of a significant impact on the airports final score. However, these scores did not make much of an impact.

Airport	Destinations	Commercial Airlines	Enplanements	Population	Interstates	International	Runways	National Parks	Final Scores	Final Ranking
Billings Logan Intl.	0.0106	0.0320	0.0027	0.0057	0.1133	0.0000	0.0850	0.0400	0.2893	**8**
Bozeman Yellowstone Intl.	0.1700	0.0800	0.0408	0.0167	0.0567	0.1700	0.0850	0.0400	0.6592	**2**
Glacier Park Intl.	0.0744	0.0480	0.0051	0.0099	0.0000	0.1700	0.0850	0.0800	0.4725	**4**
Hector Intl.	0.0213	0.0160	0.0045	0.0304	0.1133	0.1700	0.0850	0.0000	0.4405	**5**
Jackson Hole	0.0319	0.0000	0.0102	0.0105	0.0000	0.0000	0.0000	0.0800	0.1327	**10**
Joe Foss Fld.	0.0850	0.0160	0.0105	0.0330	0.1700	0.1700	0.1700	0.0000	0.6545	**3**
Missoula Montana	0.0637	0.0480	0.0030	0.0096	0.0567	0.0000	0.0850	0.0200	0.2861	**9**
Rapid City Rgnl.	0.0000	0.0160	0.0000	0.0000	0.1133	0.0000	0.0850	0.0800	0.2943	**7**
Spokane Intl.	0.1063	0.0480	0.0800	0.0699	0.0567	0.1700	0.1700	0.0200	0.7208	**1**
Tri-Cities	0.0106	0.0320	0.0006	0.0800	0.1133	0.0000	0.1700	0.0200	0.4266	**6**

Figure 12: Table of the second analysis' results.

Future Research

Potential future research for this project would be to include different types of population data. For the purpose of this project, the total population of area within the 150-mile buffer was used for a general estimate of how many people in the area would use the airport. Further types of population data that would be analyzed include households that have an education level of at least a bachelor's degree or higher and socioeconomic status. These two particular datasets tend to go hand-in-hand; the higher one's education level, the higher their socioeconomic status will be. Populations that have expendable incomes are more likely to travel for pleasure in addition to any business travel. It is important to analyze this specific population because not everyone within a 150-mile radius of an airport has the means to fly and therefore should not be included in the analysis of potential travelers. Including the population with a higher education and socioeconomic status within the analysis will provide added accuracy to the data than using the general population.

An additional type of population data that could be used is the number of yearly visitors to each of the local National Parks. Including these numbers in the analysis will create a more accurate representation of the number of travelers that use the airports. However, this population data will not be beneficial to all of the analyzed airports. In the initial analysis, two airports did not have a National Park within a 200-mile radius. Depending on the distance used to define the closest National Park to the airports will determine how many airports will have the yearly visitors' population impacting their score.

According to Britannica, a smaller airport "with a single runway, an apron, a terminal with administration area, and control tower can be built on a site as small as 75 acres" (Ashford, 2024). However, larger, more modern airports can expand out to at least 3,000 acres. Having land is an important aspect when growing an airport and will need to be considered upon future research. Land data around the airports will be collected and analyzed. If the land is available for the airport's use, then the airport can expand. If the land around the airport is already in use for residential, commerce, or other means and cannot be obtained for the airport, then the airport will not be able to expand. This variable is important when finalizing which airport should grow into a larger airport and should receive a heavier weight during the analysis.

Testing different weights for the criteria is another future research possibility. It would be beneficial to test a heavy weight on the available land around the airports and increase the weights of the runways and interstates accessible to the airport. All three of these criteria have the most impact on an airports eligibility to be expanded and grow with the increase in travelers. However, these three criteria should not be the only variables analyzed. Destination hubs, number of commercial airlines, enplanements, etc. should all still be included in the analysis as they provide beneficial information to the study. These additional criteria would have a smaller weight and even vary from each other.

Discussion & Conclusion

The goal of this capstone project was to explore the airports located in the rural North to Mid-West region of the U.S. Within this vast region, are ten small primary hub airports that are not only spread out from each other, but spread out from other larger airports. Driving to the nearest and more affordable airport takes multiple hours and even brings travelers to a different state. Despite the more spread-out population, the region is home to some of the country's most picturesque landscapes and National Parks. Expanding one of these ten smaller airports would not only increase the accessibility of the area, but will also help boost the economy, provide more direct flights to different locations, and even lower the cost for these flights. Eight criteria were identified to help select the most suitable airport for expansion. These criteria include destinations, number of commercial airlines, number of enplanements,

population, accessible interstates, international status, runway length requirements, and distance to National Parks. After completing two suitability analyses, all ten airports were ranked from the most to least suitable for expansion. Spokane International and Bozeman Yellowstone International were consistently identified as the two airports that are best suited to be expanded into larger airports. Expanding one of these airports would give this region of the U.S. the opportunity to become much more accessible. Both tourists and locals in the area will have increased opportunities to utilize the nearby airport and travel to their destination of choice. The number of visitors to the National Parks will continue to grow and see travelers visiting from farther reaches of the country as well as from other countries. Expanding a small airport and growing air travel operations in this region is an advantage to both travelers and the airline industry; increasing accessibility, lowering airfare, and discovering new destinations.

Bibliography

Airport Improvement, 49 U.S. Code § 47102(16). (2000). Retrieved January 23, 2024 from https://www.law.cornell.edu/uscode/text/49/47102 .

Airport Improvement, 49 U.S. Code § 47102(25). (2000). Retrieved January 23, 2024 from https://www.law.cornell.edu/uscode/text/49/47102 .

Ashford, Norman J. (2024). *Airport. Encyclopedia Britannica.* Retrieved April 17, 2024 from https://www.britannica.com/technology/airport

Blonigen, Bruce A. & Anca D. Cristea. (2015). Air service and urban growth: Evidence from a quasinatural policy experiment. *Journal of Urban Economics*. *86*, 128-146.

FAA. (September 30, 2022). *National Plan of Integrated Airport Systems* (NPIAS) 2023-2027. Federal Aviation Administration and US Department of Transportation. Retrieved January 6, 2024, from https://www.faa.gov/sites/faa.gov/files/npias-2023-2027-narrative.pdf

FAA. (July 22, 2016). Open Data: Airports. https://adds-faa.opendata.arcgis.com/datasets/airports1/explore?location=3.155438%2C-1.633886%2C1.67

FAA. (2024, January 25). Open data: Runways. https://addsfaa.opendata.arcgis.com/datasets/4d8fa46181aa470d809776c57a8ab1f6_0/explore?location=1 0.884413%2C-1.628764%2C2.67

FlightsFrom.com (2024). All scheduled direct (non-stop) flights. https://www.flightsfrom.com/map

Florido-Benitez, Lazaro. (2023) The location of airport an added value to improve the number of visitors to US museums*. Case Studies on Transport Policy*. *11*, 1-21.

Ivaldi, Marc, Senay Sokullu & Tuba Toru. (2015). Airport prices in a two-sided market setting: Major US airports. *TSE Working Papers*. *15*-5887.

Janke, Jason R. (2010) Multicriteria GIS modeling of wind and solar farms in Colorado. *Journal of Renewable Energy*. *35,* 2228-2234.

Lieshout, Rogier. (2012). Measuring the size of an airports catchment area. *Journal of Transport Geography*. *25*, 27-34.

LOH, Hui Shan, Kum Fai Yuen, Xueqin Wang, Ebru Surucu-Balci, Gokcay Balci & Qingji Zhou. (2020). Airport selection criteria of low-cost carriers: A fuzzy analytical hierarchy process*. Journal of Air Transport*. 1-31.

Lu, Junyu., Xiao, Huang, John A. Kupfer, Xiao Xiao, Zhenlong Li, Hanxue Wei, Sicheng Wanf & Liao Zhu. (2023). Spatial, temporal, and social dynamics in visitation to U.S. national parks: A big data approach. *Journal of Tourism Management Perspectives.* 48.

Luttmann, Alexander. (2019) Evidence of directional price discrimination in the U.S. airline industry. *International Journal of Industrial Organization*. *62*, 291-329.

National Parks Service. (2023). Visitor use data: Annual visitation statistics selease. Retrieved April 1, 2024 from https://www.nps.gov/subjects/socialscience/visitor-use-statistics-dashboard.htm.

Transportation.gov (January 23, 2024). Bureau of Transportation Statistics. National Highway System (NHS). https://geodata.bts.gov/datasets/4ca5170403664f17b0db65bee505ef16_0/explore?location=35.659864%2C-112.548350%2C4.00

U.S. Census Bureau. (2020). Total Population, 2020). Montana, North Dakota, South Dakota, Washington, and Wyoming Five Year Estimates Detailed Data [data table]. *Tables.* Retrieved from https://data.census.gov/table/ACSDT5Y2020.B01003?t=Population%20Total&g=040XX00US30$1400000,38$1400000,46$1400000,53$1400000,56$1400000

Wanore, Tesfaye D., Zelalem A. Angello & Zemed M. Fetanu. (2023). Optimized landfill site selection for municipal solid waste by integrating GIS and multicriteria decision analysis (MCDA) technique, Hossana town, southern Ethiopia. Heliyon. *9,* e21257.

Yirgu, Kaleab Woldeyohannes & Amy M. Kim. (2023). Airport choices and resulting catchments in the U.S. Midwest. *Journal of Transport Geography*. *114*, 1-17.