Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
The Duluth International Airport aviation business cluster: The impact of COVID-19 and the CARES act

Daniel L. Rust\textsuperscript{a,\ast}, Richard D. Stewart\textsuperscript{a}, Thomas J. Werner\textsuperscript{b}

\textsuperscript{a} Transportation & Logistics Management, School of Business and Economics, University of Wisconsin-Superior, P.O. Box 2000, Superior, WI, 54880, USA
\textsuperscript{b} Duluth Airport Authority, 4701 Grinden Drive, Duluth, MN, 55811, USA

\textbf{ARTICLE INFO}

\textbf{JEL classification:}
H12 Crisis management
H84 Disaster aid
L93 Air transportation

\textbf{Keywords:}
Aviation clusters
COVID-19
CARES Act
Duluth international airport
Pandemic
Disaster recovery
Aid
Relief

\textbf{ABSTRACT}

The COVID-19 pandemic struck the U.S. aviation sector in March 2020, reducing air passenger volumes by more than 50 percent versus March 2019. Airlines dramatically reduced available seat miles, leaving airports nearly vacant as the pandemic took hold. The Federal government responded with the Coronavirus Aid, Relief, and Economic Security (CARES) Act that provided aid and relief to airlines and airports. The Act generally achieved its intended purpose as a stopgap measure, but not all segments of the nation’s aviation industry received immediate relief. Utilizing data from the Duluth Airport Authority, airport tenants, as well as governmental sources, this study examines the economic impact of the pandemic during 2020 on businesses in the Duluth, Minnesota, aviation business cluster and the efficacy of Title XII under Division B of the CARES Act in addressing the adverse effects of the pandemic on the Duluth aviation cluster. This paper does not make a judgment whether future relief packages should or should not be offered.

1. Introduction

The COVID-19 global pandemic struck the U.S. aviation sector in March of 2020, reducing air passenger volumes by more than 50 percent in the United States, versus March 2019 (U.S. Bureau Transportation Statistics, 2020). Airlines reacted by dramatically reducing available seat miles, leaving airports nearly vacant as the pandemic took hold. The United States Federal government responded with enactment of the Coronavirus Aid, Relief, and Economic Security (CARES) Act (Coronavirus Aid, Relief, and Economic Security Act, 2020). Among other provisions, this $2.2 trillion aid package included $25 billion in payroll support to passenger airlines and some contractors, $25 billion in allowable loan authority for commercial air carriers and funds through the Paycheck Protection Program.

Title XII of Division B of the CARES Act directed the Federal Aviation Administration to provide $10 billion in grants to airports across the nation. CARES Act funds could only be disbursed to airport “sponsors” as defined in Section 47102 of title 49, United States Code (U.S.C.), i.e., those airport sponsors meeting the requirements under this section and identified in the Federal Aviation Administration’s National Plan of Integrated Airports System (NPIAS). An airport sponsor is typically the airport owner/operator—such as the city, county or state the airport serves. The Federal government distributed Title XII under Division B of the CARES Act funds to both commercial and general aviation airports. Eligible uses for these funds included all expenses for which airport revenues could otherwise be used. Examples included payroll, legal fees, debt servicing, pre-payment of long-term contracts, promotion of the airport, new airport development projects and ground-access projects.

While the CARES Act specifically provided aid and relief to airlines and airports in the opening stages of the pandemic in the U.S., not all segments of the nation’s aviation industry received immediate relief per Title XII under Division B of the Act. An airport is often the keystone that supports and enables an extended group of interrelated businesses that constitute an aviation business cluster. Such is the case with Duluth International Airport.

The Duluth International Airport anchors a vibrant aviation business...
cluster that includes, most significantly, the headquarters and production facility of the world’s top producer of piston-engine general aviation aircraft. At the start of the pandemic, other major entities in this cluster were a maintenance, repair and overhaul (MRO) facility providing heavy maintenance on Airbus A320 jetliners for a major commercial carrier, a fixed base operator, an Air National Guard fighter wing and a community college facility providing pilot/aircraft mechanic training. In 2019, while the airport itself had fewer than 35 total full-time employees on its direct payroll, this industrial agglomeration supported a total of 6230 area jobs, $277.3 million in annual payroll, and generated over $760 million in annual economic activity in a city with a population of approximately 87,000 (Minnesota 2019).

2. Materials and methods

At the time of this writing, enough data was not available to apply an economic impact model. However, the experience of DLH and its airport dependent business (ADB) during the year 2020 of the COVID-19 pandemic presented an opportunity for researchers to examine the impact of the pandemic on the Duluth business aviation cluster and the efficacy of the CARES Act in providing relief to the airport and businesses within the cluster, as well as develop a standardized process to assist in broadly addressing other instances of potential airport service disruptions.

The Federal Aviation Administration defines an airport as “any area of land or water used or intended for landing or takeoff of aircraft including appurtenant area used or intended for airport buildings, facilities, as well as rights of way together with the buildings and facilities. Special types of facilities such as seaplane bases and heliports are included in the airport categories” (U.S. Federal Aviation, 2021a).

CARES Act expenditures related to airports were restricted to the following:

- Primary commercial service airports, with more than 10,000 annual passenger boardings, received additional funds based on the number of annual boardings, in a similar way to how they currently receive AIP entitlement funds.
- All commercial service airports received funds based on the number of passenger boardings, the amount of airport debt and the money an airport had in reserve.
- General aviation airports received funds based on FAA general aviation categories, i.e., National, Regional, Local, Basic and Un-classified (US FAA 2020).

The COVID-19 pandemic was both unexpected and unprecedented in its economic impact to the aviation industry. Swift action was needed to mitigate at least some of the negative fallout of dramatically reduced passenger volumes and cancelled flights. The scope of the CARES Act was limited in its support to airports. The CARES Act followed the FAA definition of an airport that was not inclusive of the cluster of industries that are created and sustained by airport operations. This was due, in part, to a lack of a methodology for how to assess the economic impact of a pandemic on airport dependent businesses.

2.1. Addressing an aviation business Cluster’s economic impact from a major air service disruption

In order to assess these unknown impacts, this present study uses a five-step methodology to determine:

1. What businesses form the aviation business cluster that is airport dependent?
2. What was the impact of the pandemic on flight operations, commercial passenger traffic and air cargo at the airport?
3. What was the economic impact of the pandemic on non-airport businesses in the aviation cluster?
4. How beneficial was the CARES Act in supporting the airport as defined under the act?
5. For which businesses in the aviation business cluster did the airport portion of the CARES Act provide or not provide direct or indirect relief?

A prepared process to mitigate the economic impact of long-term disruption on the scale of a global pandemic that included impacts on firms in an airport-centered aviation business cluster did not exist prior to the COVID-19 pandemic. Airports learned from the September 11, 2001 attacks and other incidents how to operationally deal with major disruptions. However, the economic consequences, when addressed, have been a secondary concern.

The application of the methodology to the aviation business cluster centered upon the Duluth International Airport demonstrates that the economic impact of the pandemic rippled through the entire cluster, but there was no direct support to these cluster businesses under Title XII of Division B of the CARES Act. This methodology can be used in future natural or human-caused disasters to determine what entities will be impacted, as well as potential funding needs and allocations when an airport is temporarily or even permanently closed.

This methodology can be applied to other aviation business clusters to inventory airport-dependent businesses and assess the level of relief provided by the CARES Act. Planners, legislators, airport administrators, economic development agencies and other entities concerned with the potential economic impact of an airport’s full or partial closure on an aviation cluster can then use the findings to prepare more comprehensive emergency relief plans.

3. Business cluster theory

Coined by the economist Alfred Marshall, the term “industrial districts” described a geographic concentration of interconnected companies & institutions in a particular industry. (Marshall, 1920). (Belussi & Caldari, 2009). The theory proposed that the once several kindred industries became established in a region, their interconnected activities accrued benefits not found for an individual plant. Examples of these benefits included a large labor force skilled in supporting that industry, a diverse and substantial customer base, lower transportation costs, a growth subsidiary business, as well as innovation and leadership. In the 1990s Michael Porter addressed financing, technology and competition in clusters (Porter, 1990, 1998). Porter posited that in spite of globalization, clusters had become even more important because they gain competitive advantages in knowledge, relationships and motivation not available to distant competitors.

Academics have expanded the works of Porter and Marshall to include four accepted types of clusters, i.e., geographical (a collection of like industries in a geographic region), sectoral (businesses operating together supporting an economic sector), horizontal (competing businesses in the same market) and vertical (supply chain partners engaged in mutually supporting each other to improve) (Roelant & den Hertog 1999). A modern example of a high tech “sectoral cluster” is California’s Silicon Valley. There are also long-established manufacturing horizontal clusters such as the ceramic cluster of Sassuolo, Italy that has 80% of Italy’s ceramic tile production capacity. While Porter’s Cluster theory has critics, policy makers and economists have widely used it (Swords, 2013).

Not all of the economic literature deals with clusters covering large geographic regions. Yossi Sheffi’s research noted that business clusters can occur on a micro scale encompassing several blocks or even a single street (Sheffi, 2013). Sheffi’s study found that these “sub-clusters” have the key attributes found in mega-clusters, including trust, tacit knowledge exchange, collaboration, research and education and access to a supply base. DLH’s region includes all of Sheffi’s aforementioned attributes, and the U.S. Cluster Mapping Project (ed by Michael E. Porter at the Harvard Business School’s Institute for Strategy and
Competitiveness, funded by the U.S. Department of Commerce) has designated it as an aviation business cluster (US Cluster Mapping 2018).

4. Results and discussion: application of the methodology to the Duluth aviation business cluster

4.1. What businesses form the aviation cluster that is airport dependent?

The Duluth International Airport (DLH) is located approximately five miles northwest of downtown Duluth, Minnesota. In 2019 this regional non-hub airport was the third busiest in the state after Minneapolis/St. Paul (MSP) and Rochester (RST). DLH serves a large geographical area of northeast Minnesota and northwest Wisconsin with a population base of approximately 250,000 residents. Completed in 2013, the $77 million passenger terminal includes four gates as well as Customs and Border Protection facilities to process international flights.

The U.S. Air Force had a significant presence at DLH from the end of the Second World War through 1982. The airport is still home to the Minnesota Air National Guard 148th Fighter Wing, equipped with the F-16C Fighting Falcon.

Situated at an elevation of 1428′ above sea level, DLH’s 3020 acres boasts two runways that provide service for scheduled airlines, general aviation and military operations. Runway 9/27, recently rebuilt, is 10,591′ by 150′. ‘The asphalt cross runway 3/21 is 5719′ by 150′.’

The City of Duluth owns both DLH and the Sky Harbor airport (KDYT). An Executive Director and staff carry out day-to-day operations with oversight by the seven member Duluth Airport Authority (DAA) Board of Directors.

DLH is an active commercial airport with multiple daily direct flights provided by United, Delta and American to the hubs of Chicago O’Hare (ORD) and Minneapolis-St. Paul International Airport (MSP). During the period April 2019 to April 2020, the airport served 305,000 passengers on 3612 scheduled flights ranking it 198th in size in the U.S. During the same time period, 1,838,000 pounds of airfreight was transported though DLH (U.S. Bureau of Transportation Statistics, 2020a).

In addition to scheduled air service through the airport’s passenger terminal, at the start of 2020 DLH was home to several significant airport tenants. Tenants were the 148th Fighter Wing, Mono Air Duluth (fixed base operator), the headquarters of Cirrus Aircraft, AAR (provider of Airbus maintenance and refurbishment), Lake Superior Helicopters and a training facility for commercial flight ratings and aircraft maintenance education facility operated by Lake Superior Community College (LSC). There was also a FedEx terminal with scheduled flights. The 10,591′ main runway facilitates an annual air show and other special events (Fig. 1).

The Minnesota Department of Transportation (MnDOT) Office of Aeronautics’ Minnesota Statewide Airport Economic Impact Study for 2019 documented the economic impact of the 133 public airports in the state. The study estimated that DLH contributed annually $483.3 million in spending and over $760.6 million in economic activity. This in turn generated an estimated $32.9 million in state and local tax revenues. Commercial and general aviation visitors traveling through DLH accounted for over $39 million in annual spending. DLH supported a total of 6230 area jobs and $277.3 million in annual payroll. The major airport employers were Cirrus Aircraft, the 148th Fighter Wing and AAR with approximately 1000, 720 and 400 employees, respectively (Minnesota 2019).

4.2. What was the impact of the pandemic on flight operations, commercial passenger traffic and air cargo at the airport?

This question in the methodology pertains to the airport, as defined by the FAA and the CARES Act. As noted above, commercial service airport and general aviation airports received funding under the CARES Act. The Duluth International Airport is a commercial service airport with multiple types of flight operations, including scheduled passenger flights, this question would equally apply to a general aviation airport which lacks scheduled commercial service but supports airport dependent businesses as part of an aviation cluster.

4.2.1. Flight operations

For the month of February 2020, the airport experienced nearly 1300 more flight operations than the same month in 2019—an increase of more than 40 percent. Then the pandemic hit. March 2020 witnessed declines in all categories of flight operations, except air taxi. But the most significant year-to-year declines occurred in April when total flight operations plummeted to 1800—only 43 percent of total operations at DLH in April 2019. Military operations at DLH are classified as itinerant (operations from aircraft not based in DLH) and local (operations from DLH based aircraft). Fig. 2 compares itinerant to local operations. Total military operations at DLH increased by 29.2% from 4216 operations in 2019 to 5452 operations in 2020. The rationale for the increase is not publicly available information. The graph indicates a comparative decline in military operations during the initial period of the lockdown in 2020.

Not all air operations are equal. For example, a Cessna 150 will not have the same operational and economic impact as a regional jet carrying 60 passengers. However, operations are a useful metric in determining use of an airport by different aviation sectors. The data displayed in Fig. 3 show there were 5943 fewer air operations at DLH in 2020 than in 2019—a 10 percent decline. Local operations declined by 1432 operations (6.3 percent) while itinerant operations declined by 4511 operations (12.3 percent). Air taxis had the highest percentage decline, dropping 24.1 percent year-to-year. For air taxis, all months showed a decline year-to-year, with the greatest volume drop during the lockdown period.

The total carrier operations at DLH declined from 2079 in 2019 to 1769 in 2020 (Fig. 4). The 15.01 percent decline in service can be attributed to pandemic-related flight cancelations. The steepest declines occurred during the lockdown periods from March through the middle of July 2020. Significantly, air carrier flight operations reached 2019 monthly levels by August 2020 as Delta Airlines increased flight frequency in an attempt to gain market share., However, total flight operations at DLH did not reach 2019 levels until December 2020.

4.2.2. Enplaned commercial passenger volume

Duluth International Airport experienced a great start to 2020. Compared to January and February 2019, enplaned commercial passenger volume at DLH rose dramatically (Fig. 5). Thirty-four percent more passengers boarded flights at DLH in January of 2020 than January of 2019. The increase was even more significant in February when the airport experienced a 50 percent increase in enplanements compared to 2019 as the regional economy remained strong and the airport had welcomed a third carrier, Envoy (operating for American Airlines), in mid-2019 with service to Chicago’s O’Hare International Airport.

President Donald Trump declared a national emergency for COVID-19 on March 13. Minnesota Governor Tim Walz issued a statewide stay-at-home order on March 25. The number of airline passengers boarding commercial flights at DLH dropped to fewer than 7000 in March 2020, a 40 percent decrease from the month previous. But worse was coming. Only 577 passengers enplaned at DLH in April 2020, a year-over-year 95 percent decrease (Fig. 5). On average, a mere 19 people flew out of DLH per day in April. All three airlines serving DLH cut schedules as
flight load factors plummeted. Some scheduled flights reportedly departed DLH with no passengers aboard. For the month of April, DLH welcomed only 14 commercial flights—less than eight percent of the 185 commercial flights at DLH in April 2019. Envoy/American Airlines discontinued DLH service at the end of April 2020.

May enplanements remained under 1000 at 849, a 93 percent decrease compared to May 2019, aboard 57 commercial flights. Even as the U.S. and Minnesota began to reopen, DLH enplanements struggled to surpass 3000 in June, a number under 20 percent of June enplanements the year before. Monthly enplanement patterns at DLH followed season patterns for the rest of 2020, but at only 20 to 35 percent of 2019 levels. For the year 2020, DLH commercial enplanements totaled approximately 42 percent of 2019 enplanements.

4.2.3. Air cargo volume
DLH has a FedEx terminal and some additional air cargo moves through the airport. Inbound air cargo volumes, measured in pounds, remained below 2019 levels during all but one month of 2020 at Duluth International (Fig. 6). However, outbound air cargo levels at DLH surged in April 2020 to more than 85,000 pounds (Fig. 7). This was approximately 36,000 pounds more than March 2020 or April 2019—an increase likely related to the surging e-commerce sales nation-wide during the pandemic (Brett, 2021). Outbound air cargo from DLH remained above 2019 levels...
Combined inbound and outbound air cargo volumes at DLH experienced double-digit declines, year-over-year, in April and May 2020. This bucked a nation-wide trend of year-over-year increases in monthly air cargo volumes above three percent during the initial months of the pandemic (U.S. Bureau of Transportation Statistics, 2020b). Nevertheless, the strong air cargo volume at DLH for the calendar year 2020 over 2019 mirrored the nearly 9 percent increase nation-wide (US BTS 2021). These data indicate that not all segments of an aviation cluster are adversely impacted by the major disruption of passenger air service.

As found below, many entities and services at Duluth International Airport experienced the economic impact of the dramatic reduction of flight operations and commercial air passenger enplanements due to the pandemic.

4.3. What was the economic impact of the pandemic on non-airport businesses in the aviation cluster?

While the second step of the methodology addresses the airport’s operational aspects, this third step addresses the financial implications for the other aviation business cluster entities (not included in the FAA or CARES Act definition of “airport”) of those changes in airport operations.

4.3.1. COVID-19 impact on ground transportation

4.3.1.1. Car rental services. DLH hosts six car rental service companies including Alamo, Avis, Budget, Enterprise, Hertz and National. After enjoying gross receipts in January higher than 2019 levels for the month, car rental companies at DLH experienced a dramatic slide in gross receipts as the pandemic took hold (Fig. 8).

April gross receipts totaled less than $65,000, falling from more than $375,000 in January. Year over year, April’s gross receipts were a mere
17 percent of April 2019 receipts. Even as air traffic began to rebound in May, car rental services at DLH had gross receipts that were only 16 percent of 2019 levels. Rental car gross receipts for 2020 totaled less than 50 percent of the 2019 total.

4.3.1.2. Parking services. Parking revenue is a highly significant income source at DLH. Gross receipts in January and February 2020 totaled much higher than the same months the prior year, reflecting increased passenger boardings early in 2020 (Fig. 9).

Reduced passenger traffic due to COVID-19 slashed parking services gross receipts to a meager $4700 in April from more than $154,000 only two months before. Parking revenue made a small recovery in May to $7200 but remained far below the $133,000 in May 2019. Following a seasonal pattern, parking revenue climbed month-over-month until October before dropping again in the last two months of the year.

4.3.1.3. Landline. Targeting travelers from the Duluth region who fly from Minneapolis-St. Paul International Airport (MSP) but wish to not drive their own motor vehicle, Landline offered nonstop bus service between Duluth International and MSP multiple times per day (Landline, 2020). The company started service in June 2019 and saw its DLH-MSP passenger traffic grow to 2053 passengers by February 2020. The pandemic hit the company hard as traffic on the route dropped to a mere 121 passengers taking the 3-h bus trip in April 2020. Landline passenger numbers began to slowly recover in May and peaked at nearly 900 in July before dropping again as the fall season took hold in the

Fig. 5. DLH total enplaned passengers, January–December 2020 versus 2019. Source: Duluth Airport Authority Board, 2020.

Fig. 6. Inbound Air Cargo at DLH, in pounds, January–December 2020 versus 2019. Source: Duluth Airport Authority 2020.
4.3.2. COVID-19 impact on food services

4.3.2.1. Food services. Food service gross receipts at DLH followed a similar pattern to those of parking services in the first five months of 2020 (Fig. 10). The only restaurant in the DLH terminal, Arrowhead Tap House, is located past TSA security in the passenger boarding area and is largely dependent on ticketed passengers.

As passenger enplanements slowed to a trickle in April 2020, food service gross receipts fell to less than $800 for the entire month. Only four months earlier, receipts totaled nearly $60,000 per month. Food service gross receipts remained below $20,000 each month for the remainder of the year. For the entire year of 2020, food service gross receipts totaled a mere 28 percent of the total for 2019.

4.3.3. COVID-19 impact on maintenance, repair and overhaul

4.3.3.1. AAR. One of the largest commercial aviation maintenance, repair and overhaul (MRO) providers in North America, AAR in 2019
had nearly 6000 employees and $1.8 billion in annual revenue. As of 2019, AAR had approximately 350 employees at its Duluth location with plans to boost that number to 400. AAR partnered with Lake Superior College to establish a talent pipeline from the school to the AAR facility across the runway. AAR offered tuition assistance to students who agreed to at least two years of employment at AAR. The company even considered offering free kayak and mountain bike rentals to attract more new hires (Johnson, 2019, September 24).

In April 2020, the company revealed that it anticipated an 80 percent reduction in MRO work across all its facilities as air passenger traffic fell off due to COVID-19. Less than a year earlier AAR had inked a 20-year lease for its facility with City-owned Duluth Economic Development Authority (DEDA), owner of AAR’s maintenance hangar at DLH. Monthly rent was set at $36,500 per month. With the pandemic looming, the DEDA waived three months of rent for AAR—totaling more than $111,000. Nevertheless, facing severe cutbacks in United Airlines’ demand for A320 heavy maintenance during the pandemic, AAR decided to close its Duluth facility as of July 24 and laid off its remaining 269 Duluth employees. AAR planned to relocate equipment from Duluth among its other locations; four in the US and two in Canada (Lovrien, 2020, May 21). The City of Duluth negotiated a $210,422 lease buyout from AAR in August 2020 because the company failed to abide by its agreement to give at least 180 days’ notice before terminating its lease (Johnson, 2020a, 2020b, August 17).

Many of the AAR employees laid off from the shuttered Duluth facility became eligible for financial assistance to seek additional educational opportunities for jobs outside of the Duluth aviation cluster. This funding was a direct cost attributed to the shutdown resulting from COVID-19 impacts. Recognizing the long-term implications of skilled aerospace talent leaving the region, the Duluth Economic Development Authority (DEDA) and the Duluth Airport Authority actively sought to find another tenant to lease the maintenance hangar previously used by
4.3.4. COVID-19 impact on general aviation

4.3.4.1. Monaco air Duluth. Monaco Air Duluth, the FBO at DLH, is responsible for refueling both GA aircraft and commercial airliners—delivering low-lead avgas and jet fuel. Consistent with increased air passenger traffic during the first two months of 2020 compared to the prior year, Monaco Air’s sale of jet fuel (measured in gallons) at DLH exceeded 2019 levels (Fig. 11).

As the pandemic hit, aviation fuel sales slumped. In April 2019, Monaco Air sold nearly 134,000 gallons of jet fuel. The same month in 2020 the company sold fewer than 58,000 gallons. Jet fuel sales declined even further the following month to under 46,000 gallons—only 25 percent of May 2019 sales. Monaco Air’s jet fuel sales figures remained far below 2019 levels for the remainder of 2020. Despite reduced demand for its array of services, Monaco Air continued serving GA and commercial customers 24/7 (Monaco, 2021).

4.3.4.2. Lake Superior Helicopters. Lake Superior Helicopters (LSH) provides training and platforms for rotary wing pilot certification. LSH also offers tours, aerial mapping services and assists in forest fire operations. Demand for helicopter pilot flight training at Lake Superior Helicopters declined due to COVID-19, but the company intends to expand into avionics repair and helicopter maintenance.

4.3.4.3. Duluth Airshow. Duluth International Airport hosts the annual Duluth Airshow—one of the largest airshows in the upper Midwest. The airshow draws nearly 50,000 people to Duluth with an economic impact of approximately $10 million each year. Originally scheduled for July 18 and 19, organizers postponed the 2020 Duluth Airshow until 2021 due to COVID-19 (COVID-19 postpones 2020).

4.3.5. COVID-19 impact on higher education

4.3.5.1. Lake Superior College. Duluth’s Lake Superior College (LSC) operates the Center for Advanced Aviation (CAA) in a 40,000 square-foot leased building on the south side of DLH’s main runway. The CAA is home to Lake Superior College’s aviation program that includes pilot training and aircraft maintenance. Both two-year programs experienced double-digit growth over several years prior to the pandemic. In the fall of 2016, there were 75 students enrolled in the aircraft maintenance program and 55 students in pilot training (Lake Superior College, 2017).

Cirrus Aircraft and AAR benefited from LSC’s aviation program establishing a talent pipeline of graduates. In early 2020, Cirrus Aircraft, AAR and regional air carriers eagerly sought to bring even more of the program’s graduates into their workforces. For example, approximately 50 students in the LSC aviation program in early 2020 worked at AAR, and graduates of the LSC aviation program made up nearly half of all AAR employees in Duluth (Lovrien, 2020, May 21).

Within a few weeks of the start of the pandemic, an aviation labor shortage in the Duluth’s aviation cluster turned into labor furloughs and layoffs as demand for new pilots and mechanics disappeared. This was not the case nationwide. General aviation continued to grow. Many of the older aviation workforce members decided to retire early due to the pandemic. These combined actions resulted in demand for new talent slightly increasing even though commercial flights had drastically dropped (Johnson, 2020a, 2020b, August 17).

As indicated in Fig. 12, LSC did not see a decline in enrollment during the pandemic period covered by this research. The pandemic initially had an impact on graduation from the flight program by limited flying due to COVID restrictions. Aviation Maintenance Technology and Aviation management programs did not face the flight restriction issues. The LSC Aviation Management major that declined has never been dependent on the operation of DLH.

While total enrollment in the LSC aviation programs did not decline...
significantly due to COVID-19, the loss of AAR as a local employer of program graduates meant that students completing the program had few employment opportunities within the Duluth aviation cluster. Graduates, as a rule, now sought employment outside of the Duluth region. This negative trend largely negated a multi-year effort among public and private stakeholders to foster high-wage aviation maintenance jobs in the Duluth aviation cluster (Wills, 2021).

4.3.6. COVID-19 impact on airframe manufacturing

4.3.6.1. Cirrus Aircraft. Cirrus Aircraft produced 384 of its SR-20/SR22/SR22T aircraft at its Duluth factory in 2019—more than any other manufacturer of piston-engine GA airplanes in the world. Cirrus also increased production in Duluth of its jet-powered SF50 to 81 in 2019 for a combined total of 465 aircraft delivered (Fig. 13) (General Aviation Manufacturers Association, 2019). Ranked by full-time-employees, Cirrus aircraft is the second largest manufacturer in the Duluth region (Business North 2019).

In late March 2020, Cirrus announced four-week furloughs of some of its 1000 Duluth employees (Johnson, 2020a, 2020b, March 27). As the nation faced a shortage of personal protective equipment (PPE) and equipment needed for saving lives during the pandemic, Cirrus Aircraft employees manufactured more than 30,000 medical-grade face shields and nearly a thousand respirators by mid-April (Plane & Pilot, 2020).

As seen in Fig. 13, Cirrus produced only 74 aircraft during Q2 of 2020—49 fewer than Q2 of 2019. Nevertheless, production rebounded in Q3 when the company produced more than it had in Q3 of 2019. Overall production declined by 11 aircraft in Q4 2020 compared with Q4 in 2019. Cirrus produced only 45 fewer aircraft in all of 2020 versus the previous year.

4.3.7. COVID-19 impact on military activity

4.3.7.1. Minnesota Air National Guard’s 148th fighter wing. The 148th Fighter Wing of the Minnesota Air National Guard was a bright spot for Duluth’s aviation cluster as the base’s workforce remains stable. The unit continued with normal operations and drill schedule.

Part of Operation American Resolve, aircraft and personnel from the 148th participated in statewide flyovers to honor first responders and essential workers toiling on the frontlines of the pandemic (Minnesota National Guard Public Affairs, 2020). These flights contributed to the near doubling of local military flights at DLH in May 2020 compared with the same month in 2019 (Fig. 4). Additionally, personnel from the base assisted healthcare workers with COVID-19 testing made available for free to the public around the state of Minnesota (Erickson, 2020, May 23). Wing personnel continued to assist with the federal response to COVID-19 by administering vaccine doses to Minnesotans in early 2021 (148th Fighter Wing Public Affairs 2021).

4.4. How beneficial was the CARES act in supporting the airport as defined under the act?

4.4.1. The DAA’s response to COVID-19 economic impact on DLH

Up until early March 2020, air commerce at the Duluth International Airport was still riding a significant economic wave. Passenger activity was up in January and February, year-over-year by substantial amounts. That all changed in mid-March as the pandemic took hold.

4.4.1.1. CARES act funding. By mid-March, the entire economic ecosystem in the U.S. had been disrupted. Air travel volumes had dropped precipitously, disrupting activity-based revenues that make up a large portion of the Duluth airport’s income. The DAA’s Executive Director frequently provided the region’s Congressional delegation with

|                      | Fall 2020 | Fall 2019 | Fall 2018 | Fall 2017 | Fall 2016 |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Aviation Maintenance Technology | 78        | 79        | 60        | 77        | 75        |
| Professional Pilot   | 64        | 62        | 57        | 59        | 55        |
| Aviation Management  | 2         | 2         | 6         | 14        | 16        |
| Total Enrollment in Aviation Programs | 142 | 140 | 118 | 138 | 128 |

Fig. 12. Lake Superior Community College Aviation-Based Programs, by declared majors. Source: Fanning, 2021.

Fig. 13. Cirrus aircraft production by model, Q1 2019-Q4 2020. Source: General Aviation Manufacturers Association 2020, 2021.
information about how the pandemic’s shutdown of the economy was impacting air travel, the aviation cluster and the DAA. The DAA’s Executive Director advocated for financial assistance from Congress in concert with the Association of American Airport Executives. The pandemic was still in its infancy, but it was clear the disruptions to air commerce would be severe. Most airports would require financial assistance to continue to maintain safe and secure facilities, pay debt service, and press forward with overhauling infrastructure that would continue to deteriorate even through it was not experiencing much civilian use in the short term.

The DAA received $5.27 million from the CARES Act. The airport primarily used CARES Act funding to mitigate revenue shortfalls in 2020. As of the publishing of this article the DAA continued to mitigate revenue shortfalls in 2021.

4.4.1.2. Emergency declaration by the Duluth Airport Authority. The DAA’s Enabling Legislation of 1969 granted the DAA substantial autonomy from the City of Duluth but did not deem the DAA a political subdivision. The Minnesota Emergency Act of 1996 enables political subdivisions to coordinate emergency response and request aid should the need arise during a variety of catastrophes.

The DAA’s Executive Director communicated with the Minnesota Department of Transportation’s (MNDOT) Office of Aeronautics and the City of Duluth, requesting their assistance in appealing to the Governor’s Office for inclusion of airport authorities as an eligible participant of the Minnesota Emergency Act, either through executive order or special legislation. The DAA is responsible for critical infrastructure and charged with maintaining public safety. Costs related to pandemic response were anticipated to occur. Access to state aid or FEMA disaster funding would help the DAA fulfill its mission during a difficult financial period caused by the COVID-19 economic downturn. At the time of this writing, FEMA disaster funding has not been secured. The DAA may have to pursue special legislation in order to gain eligibility under the Minnesota Emergency Management Act.

In addition to securing a path for disaster response funding, the DAA staff faced a host of other challenges that were important to address in an expeditious manner, from tenant payment relief requests to suspending personnel policies that were not practical during the COVID-19 pandemic. Drafted by the DAA’s Executive Director and approved by the DAA Board, an emergency declaration empowered the DAA’s Executive Director to address these issues and coordinate with emergency management agencies as needed during the response.

4.4.1.3. Financial relief for tenants. A few weeks into the COVID-19 pandemic, it was evident that almost all aviation cluster businesses at Duluth International were negatively impacted. DAA staff received requests for financial relief from tenants, ranging from rent deferments to waivers of minimum annual guarantees. The DAA evaluated each of these requests on a monthly or quarterly basis and approved only short-term deferrals or waivers. None extended to the end of the calendar year because so much was unknown about how long activity and resultant revenues would take to recover. However, each deferment the DAA granted came with a commitment to further dialog and reevaluation of the relief should the need arise for more relief later in the year. The DAA also asked each tenant requesting relief to first exhaust other programs, such as the Paycheck Protection Program and other Federal and State assistance initiatives. Many of these initiatives were set up so that businesses could continue to pay basic payroll, rent and utilities expenses.

4.4.1.4. DAA’s operating budget adjustments and cashflow management. Cashflow management became a priority early in the DAA’s response to the COVID-19 economic downturn. Some revenue centers experienced income approximately 70–80 percent lower than budgeted levels. As the crisis deepened in mid-March, the DAA sought to conserve cash on hand for the foreseeable future. The DAA Executive Director asked department leaders to make only essential expenditures and, where possible, cut budgetary outlays for the rest of the fiscal year. This resulted in an approximate 10 percent reduction in budgeted disbursements.

In late March, the DAA received access to CARES Act reimbursement funding. Staff continued to plan as if there will not be additional relief funding available to the DAA as the airport’s leadership planned for a protracted economic recovery.

4.4.1.5. Capital planning and construction initiatives. While response to the pandemic was a priority, ongoing planning initiatives never took a hiatus. Two construction projects planned for the airfield in 2020, i.e., a mil and overlay of approximately one mile of taxiway as well as a commercial service apron expansion, continued. The CARES Act provided 100 percent Federal share for Airport Improvement Program Funding of approved capital improvement projects in Federal fiscal year 2020. Airport staff determined that the DAA could cashflow both projects. At a combined cost of approximately $2 million, completion of the projects in 2020 provided an economic stimulus to the region’s economy during the economic downturn.

4.4.1.6. Airport bonds. Many airports issue bonds as a means of raising funds for needed projects. The interest rates and or/cost of bonds vary with the credit rating of each airport. The bonds are rated by internationally recognized companies such as Moody’s and/or Fitch. These bond rating companies use historical performance data to grade an airport’s bonds from AAA to D on a best-to worst-case scenario credit rating. The ratings are normally forward looking based on historical performance and anticipated market changes.

The decline in traffic due to COVID resulted in a significant drop in revenue. Normally the loss of revenue and the resulting inability to make key payments would negatively impact an airport’s credit score and bond ratings. If the revenue reduction is short term and the airport has significant unrestricted cash reserves the bond downgrade may be minimal. One of the benefits of the CARES Act to airports was to offset revenue declines and increase liquidity.

The uncertainty about when normal flight operations would start up resulted in Fitch keeping the same letter rating on many airports’ bonds but in early 2020 advising a Negative Rating Outlook for these airports. In April 2020 select airports’ rating outlooks were upgraded to “Stable” by Fitch. However as noted in a Fitch report:

While the passage of the CARES Act reduces the risk of downgrades somewhat, it is not enough to result in Stable Outlooks at this time given the remaining uncertainties in the sector, including but not limited to, the severity and duration of enplanement losses, the length of the recovery period, the extent of revenue underperformance, and the financial health, willingness, ability of air carriers to make full and timely payments (Fitch Ratings 2020).

The continued reduced traffic due to the pandemic has resulted in rating agencies assessing each airport’s financial health and ability to meet bond obligations. Fitch commenced COVID stress test for an airport’s ability to meet the contractual obligations of bond issues under different scenarios over the remainder of 2020 and into 2021.

Duluth International Airport has no bonds currently, but perspective can be gained from an examination of the impact on another airport’s bonds. Burlington International Airport (BTV) is an example of a regional airport, as defined by Fitch, that has had its bond rating improved during the pandemic. In March 2021, Fitch removed BVT’s BBB-rated revenue bonds from a Rating Watch Negative (RWN). However, the Rating Outlook for BTV remained negative (Fitch Ratings 2021). In addition to assessing the ongoing financial health of airports, rating agencies plan to analyze current and future traffic and revenue impacts caused by possible changes in air travel patterns from the pandemic.
Disruption and determining the effectiveness of the CARES Act in mitigating the impact of COVID-19. The application of the methodology to the Duluth International Airport aviation business cluster demonstrates that the economic impact of the pandemic rippled through the entire cluster adversely impacting many entities. Similar to commercial airports globally, the COVID-19 pandemic decimated air travel volumes through Duluth International Airport starting in March 2020. The economic impact of the crisis affected every service and tenant at the airport such as the FBO, food services, car rental services and parking services. The pandemic also directly resulted in the closure of an MRO facility with hundreds of employees but had limited negative impact on the airport’s Air National Guard base, airframe manufacturer and higher education facility.

Fortunately, the Duluth Airport Authority received more than $5 million in Federal funds though the CARES Act during the early months of the pandemic. These funds helped offset the airport’s significant revenue losses as airline flight operations and commercial air passenger volume collapsed. However, not all parts of the Duluth aviation business cluster directly or equally benefited from CARES Act relief funds—as demonstrated in this study’s application of a five-step methodology to examine the COVID-19 impact on the Duluth aviation cluster. There was no direct support to these cluster businesses from Title XII of Division B of the CARES Act nor did the CARES Act address specifically from whom airport tenant businesses should seek relief. This is not a fault of this aspect of the CARES Act as it accomplished what it set out to do. However, the observed economic effects of the pandemic highlight the interconnectedness and interdependency of an aviation cluster.

Plans to mitigate the economic impact of long-term disruption on the scale of a global pandemic that included impacts on airport dependent businesses did not exist prior to the COVID-19 pandemic. Airports learned from the September 11, 2001, attacks and other incidents how to operationally deal with major disruptions. However, the economic consequences, when addressed, have been a secondary concern. Similar to other airports, the DAA had established procedures for addressing short-term impacts to the Duluth International Airport, but the Authority lacked a planning document to follow during a long-term event—such as a pandemic. The DAA resorted to an ad hoc approach when cluster members came to the DAA asking for relief from rents. In time of crisis, implementing pre-planned procedures is preferable as cluster members instinctively turn to the DAA for guidance and relief. All cluster members would have benefited from a formal planning resource instead of figuring out a response in the moment. A decision to create a broader based relief instrument would require future research.

5. Conclusions

This study presented a five-step methodology, applied to the Duluth aviation business cluster, for identifying the impact of a major air service disruption and determining the effectiveness of the CARES Act in mitigating the impact of COVID-19. The application of the methodology to the Duluth International Airport aviation business cluster demonstrates that the economic impact of the pandemic rippled through the entire cluster adversely impacting many entities. Similar to commercial airports globally, the COVID-19 pandemic decimated air travel volumes through Duluth International Airport starting in March 2020. The economic impact of the crisis affected every service and tenant at the airport such as the FBO, food services, car rental services and parking services. The pandemic also directly resulted in the closure of an MRO facility with hundreds of employees but had limited negative impact on the airport’s Air National Guard base, airframe manufacturer and higher education facility.

Fortunately, the Duluth Airport Authority received more than $5 million in Federal funds though the CARES Act during the early months of the pandemic. These funds helped offset the airport’s significant revenue losses as airline flight operations and commercial air passenger volume collapsed. However, not all parts of the Duluth aviation business cluster directly or equally benefited from CARES Act relief funds—as demonstrated in this study’s application of a five-step methodology to examine the COVID-19 impact on the Duluth aviation cluster. There was no direct support to these cluster businesses from Title XII of Division B of the CARES Act nor did the CARES Act address specifically from whom airport tenant businesses should seek relief. This is not a fault of this aspect of the CARES Act as it accomplished what it set out to do. However, the observed economic effects of the pandemic highlight the interconnectedness and interdependency of an aviation cluster.

Plans to mitigate the economic impact of long-term disruption on the scale of a global pandemic that included impacts on airport dependent businesses did not exist prior to the COVID-19 pandemic. Airports learned from the September 11, 2001, attacks and other incidents how to operationally deal with major disruptions. However, the economic consequences, when addressed, have been a secondary concern. Similar to other airports, the DAA had established procedures for addressing short-term impacts to the Duluth International Airport, but the Authority lacked a planning document to follow during a long-term event—such as a pandemic. The DAA resorted to an ad hoc approach when cluster members came to the DAA asking for relief from rents. In time of crisis, implementing pre-planned procedures is preferable as cluster members instinctively turn to the DAA for guidance and relief. All cluster members would have benefited from a formal planning resource instead of figuring out a response in the moment. A decision to create a broader based relief instrument would require future research.

Further research opportunities might include the application of this methodology to analyze the effectiveness of the CARES Act for providing economic relief to the public and private entities of other aviation business clusters as well as the effectiveness of other sources of financial relief to entities of an aviation cluster. At the end of the pandemic, additional data will become available on the economic impact to DLH’s aviation business cluster. An analysis at that point would be helpful in assessing the long-term impacts, trends and findings discussed in this study. This study has indicated that, while DLH is essential to an aviation business cluster, operations such as AAR may fail even when passenger traffic at DLH is rebounding. This study has revealed the complexity of linkage in aviation business clusters.

Looking beyond the COVID-19 pandemic, this methodology might serve as the starting point for creating strategies for possible financial relief to an aviation cluster in the event of a major air service disruption, whatever the cause or duration. The application of this methodology to other aviation clusters, or even the aviation sector in general, could help stakeholders identify a more comprehensive aid strategy (if financial aid is made available) to cluster entities in the wake of a future air service disruption that significantly impacts the economic viability of an aviation cluster.

Declarations of interest

Daniel Rust—None
Richard Stewart—None
Tom Werner—potential competing interest as an employee of Duluth Airport Authority

CRediT authorship contribution statement

Daniel L. Rust: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.
Richard D. Stewart: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.
Thomas J. Werner: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

Acknowledgments

The authors wish to thank the staff of the Duluth Airport Authority for their assistance. The authors also thank Don Monaco, owner of Monroe Air Duluth; Trever Wills, Associate Dean of Business & Industry at Lake Superior College; and Daniel Fanning, Vice President of Institutional Advancement and External Relations at Lake Superior College. Finally, the authors express their appreciation for the valuable feedback they received at the 62nd International Meeting of the Transportation Research Forum, especially from discussant Fecri Karanki of North Dakota State College of Science.

References

Beluski, F., & Caldari, K. (2009). At the origin of the industrial district: Alfred marshall and the cambridge school. Cambridge Journal of Economics, 33, 335–355. https://doi.org/10.1093/cje/ben041
Brett, D. (2021). US cargo-focused airports report rapid growth in 2020. Air Cargo News. Retrieved at https://www.aircargonews.net/business/statistics/us-cargo-focused-airports-report-rapid-growth-in-2020/ (Accessed 20 May 2021) Accessed. Business North. (2019). Directory of business & industry-2019.
Coronavirus aid. (2020). Coronavirus aid, relief, and economic security (cares) act (P.L. 746, Public Law 116-136). Retrieved from https://www.govinfo.gov/content/pkg/PLAW-116publ136/html/PLAW-116publ136.htm . (Accessed 27 July 2020) Accessed. COVID-19 postpones duluth airshow. (2020). Retrieved from https://duluthairshow.com/covid-19-updates/. Accessed: July 20, 2020. Duluth Airport Authority Board. (2020). Board agendas and minutes. Retrieved from https://www.duluthairport.com/about/board-of-directors/daab-agendas-minutes/. (Accessed 20 May 2021) Accessed.
Ericksen, A. (2020). Minnesota line up for covid-19 testing at the duluth armory. Duluth News Tribune. May 23 https://www.duluthnewstribune.com/news/md/coronaviru
