Improving Logistics in Alaska through Drones

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Abstract

Alaska is a place that has challenges to logistics due to its geography and the remoteness as a region which affects the flow of goods and services statewide. Drones have become an emerging technology that offers solutions which provide more reliable logistics to remote regions. Alaska's difficulties with logistics stem from seasonal weather patterns and remoteness of towns. These difficulties severely hinder logistics due to infrastructure being unavailable or limited. Communities depend on logistics to receive critical supplies to sustain life; any gap in services can have dire consequence and even be fatal. During the winter and times of low temperatures, primary forms of logistics like planes and marine transportation can be halted for days. Drones are not restricted as much as other transportation modes and alleviate the possibility of loss of human life due to transportation accidents. Drones present an opportunity to provide logistics in both in humanitarian and commercial realm that is more reliable and transport goods that would otherwise be unavailable. This technology represents a chance to provide solutions to food, water, medical, and other supply needs to remote villages. Drones can be flown day or night with an opportunity to improve logistics throughout Alaska from existing forms of logistics.

Keywords**:** Humanitarian logistics, Drone, Alaska, remote regions, APSARA Glider, Pouncer

Introduction

Through the humanitarian field each disaster or operation provides aid workers and organizations with lessons learned and valuable experience that can be passed on to similar situations. It is through this knowledge that operations and response to disasters improves and evolves. Through improved logistics and supply chain management, time is saved and loss of life is minimized. Logistics both locally and worldwide are important because it boils down to providing goods and services to those who need it. These operations are not always easy solutions and illustrate a need to think creatively and improve delivery methods and efficiently improve timelines if possible. Diverse remote regions that differ in geography, financial demographic, and resources can still offer examples for workable solutions to logistical challenges. Even if solutions do not exactly match up to dissimilar remote regions it can lead to improved results due to knowing what works and what doesn't. Knowing what doesn't work can be just as important as it leads to trending towards solutions that are workable given a situation. Organizations, governments, and companies can share this information to help cooperate and coordinate when undertaking logistical challenges, humanitarian or otherwise.

When analyzing logistics in places that have historically been challenging, the state of Alaska comes to mind. The Great Frontier has been a trying place for logistics operations due in part to seasonal weather patterns, periods of extended darkness, the remoteness of the state and places which can only be accessed by one mode of transportation. By taking a look at how Alaska currently deals with their logistical challenges there can be updated technologies which help to improve logistics as a whole. Newer technologies such as drones can provide a way for Alaska to evolve their logistics to be both reliable and functional no matter what time of year.

Through the examination of how Alaska deals with its own logistics, there can be other options explored to refine and improve operations which speed up operations and deliver the most goods.

Literature Review

Alaska

The state of Alaska covers over 663,268 square miles, which is larger than Denmark or Japan (Inbound Logistics, 2014). Despite the size of the state, the population density averages only one person per square mile (FAA, 2001). Alaska has nine distinct physiographic and environmental regions which have temperatures that range from +100°F to –80°F (FAA,2001). Glaciers account for more than five percent of the state. Alaska has temperate rainforests in the southeast, tundra in the west and central, and in the north more than 40 active volcanoes and volcanic fields. Alaska has 17 of the 20 highest peaks in the United States and 50 mountain ranges (FAA,2001). Alaska's geography demands unique solutions for logisticians to find ways to transport goods around the state.

Throughout the state, most towns, especially in the northern region, are isolated and can only be accessed at certain times of the year. To add to the complicated logistics issue, some areas can only be accessed by one mode of transportation which makes delivering goods and services a long and complicated process. The remoteness of the state is not the only challenge to logistics as weather plays an important part of how goods and services get for one point to the other. The average annual temperature is 32.8 degrees Celsius which is just above freezing (Inbound Logistics, 2012). To understand the complications that weather plays on delivery of goods and services, logisticians must analyze weather patterns and seasonal events which can have a strong impact on logistics.

Winter Weather

The winter season in Alaska occurs from November through February most years. However, snow and icy conditions may come earlier and occasionally drag on through March. Additionally, high winds can often be a common occurrence in the winter months. These high winds in conjunction with low temperatures can wreak havoc to airline flights. In fact, when temperatures reach -50 below gasoline starts to congeal and reciprocating engines become useless (FAA, 2011). Planes have been known to be delayed by several days or more waiting out weather which can have a disastrous effect of perishable goods and emergency services.

Winter sea ice becomes a blockage to transportation routes by boats that are accessible in the spring and summer months. According to Lynden Marine, a barge transportation company, winter services are provided by large ships as they can navigate through the sea ice. These ships are often more expensive to run. Conversely, when sea ice is not a concern, deliveries by barge can serve more remote communities at a fraction of the cost. The disadvantage of these barge services is that they are not equipped to transit waters where ice is present. As a result of winter ice, service can be suspended for many days or weeks. Barges are preferred but are not always a viable option. With a short time frame to deliver goods and services, remote Arctic communities might only get deliveries once or twice during the summer. These months must be taken advantage of and planned for accordingly.

Low temperatures and sea ice are not the only factor that can severely slow deliveries. Extended times of light and dark can also affect logistical decisions.

Starting on the Winter Solstice (December 21st) and continuing through January 31st, the whole state of Alaska begins to experience extended periods of darkness. The further north you go, the less light you will have during these times. For example, during the Winter Solstice, Anchorage will have over eighteen hours of darkness. However, on the same day the city of Fairbanks located further north will have over twenty hours of darkness. Conversely, the city of Barrow located at the extreme northern tip of the state experiences 67 days of continuous darkness. It is significant to note seasonal periods of darkness because of the corresponding drops in temperature which add additional challenges to delivering goods and services to needy communities.

Conversely, after the Spring Equinox (March 21), the pendulum swings the other way and the state starts gaining daylight at an average of six minutes a day. As a result, in the summer there is more daylight than darkness. This can be advantageous for modes of transportation due to improved visibility and warmer temperatures during these months.

Other than the challenges presented by weather and periods of extended darkness, Alaska has its own set of natural disasters that can happen from time to time. They range from tsunamis to earthquakes and avalanches.

Earthquakes and Tsunamis

The state of Alaska sits on two tectonic plates, the Pacific and the North American. The Pacific Plate slowly moves toward the land two inches per year. When the Pacific and North American Plates meet, oceanic rocks are forced under the more buoyant continental rocks of Alaska mainland which is known as subduction (UAF,2016). Generally, when an earthquake occurs that exceeds 8 or 9 on the Richter Scale, its epicenter is located at a shallow spot in the subduction zone (UAF,2016). In the Southeast portion of the state, the Pacific Plate affects the region in a different way. The fault line slips from side to side in a northwest direction which causes severe compression and shearing on the nearby geography. Alaska averages about one earthquake every 15 minutes (UAF,2016). These earthquakes vary in strength and length. The state government of Alaska maintains an earthquake center run by the University of Alaska in Fairbanks. The Earthquake Center has used the Transportable Array Project to help add new seismic stations in areas that were previously unmonitored. The Earthquake Center has recorded over 150,000 earthquakes in the last five years (UAF,2016). Early earthquake warning is critical in Alaska since earthquakes of 6 and 7 magnitudes are common and can happen anywhere in the state (UAF,2016). Moreover, three of the twelve largest earthquakes recorded worldwide occurred in Alaska (UAF,2016). The Earthquake center monitors daily seismic activity and communicates it to the public through a series of shake-up maps, recent earthquake maps, information releases, and offers information to the public on how to prepare for an earthquake (UAF,2016).

Large, offshore earthquakes of higher magnitude are a major contributing factor in causing tsunamis. Starting from the first recorded tsunami that affected Alaska in 1737 from Kamchatka, Russia, there have been 92 tsunamis which have directly affected the state (UAF, 2016).

The State of Alaska has the greatest risk for tsunamis of all the United States. Due to the frequency of earthquakes, coastal communities have needed to come up with contingency plans for evacuating and keeping people safe. One of the prime examples of the destruction that a tsunami can cause can be seen in the old city of Valdez. In 1964, an earthquake of 9.2 magnitude hit Alaska (USC,2018). The city of Valdez was built upon unconsolidated deltaic sand and gravel which were extremely unstable when subject to sustained shaking. The earthquake created shock waves that caused the sediment to spontaneously liquefy which prompted the ground to lose all bearing capacity. In total, an area about 4,000 feet long by 600 feet wide sloughed into the waters of Port Valdez (USC,2018). Most of the port facilities were destroyed due to the force created by the displacement which triggered a local tsunami. The tsunami was estimated to be as high as 30 to 40 feet (USC,2018). What made this a particularly deadly disaster was that the tsunami destroyed the port facilities before the ground stopped shaking. Additionally, the crude oil tanks owned by Union Oil Company which were located near the port, ruptured and burned down the remaining structures. After the tsunami, the city of Valdez moved to its current location on more stable ground and out of the direct path of potential future tsunamis. The city of Valdez has remained in its current location for more than 54 years without incident.

Together, the Alaska Division of Geological and Geophysical Surveys and the Alaska Division of Homeland Security and Emergency Management have come up with plans to map out and evaluate potential areas that have a strong possibility of being inundated during a tsunami (UAF, 2016). This inundation project uses models which are calculated by using tsunami wave dynamics. Over 22 communities have already been a part of the project with published findings (UAF,2016). The project selects communities based on the likelihood of their tsunami hazard exposure, location, infrastructure, availability of data, and willingness to incorporate the results in a comprehensive mitigation plan. In addition to inundation maps, some communities like Juneau and Cordova, have developed pedestrian travel time maps (UAF, 2016). These populations already have developed well-defined tsunami scenarios which enables them to estimate the time it would take to safely get to higher ground. These models assume evacuation by foot as well as most likely there will be barriers and expected breakdowns within the infrastructure.

To illustrate the challenges to transportation and local access, look no further than the state capital of Juneau. Juneau is the largest state capital in the United States, with a population of 51,000 residents, yet can only be accessed by air or boat (Dihle,2014). In fact, it is the only state capital in the United States that does not have a direct road system to it. This is not uncommon in southeast Alaska as this is the norm for over 12 communities in the region (City-Data.com, 2018). Juneau is cut off from the rest of the world by an ice-field spanning 1,500 miles in the winter time, a dangerous mountain range, and the Pacific Ocean (Dihle, 2014). There has been a push since the 1970's to build a road connecting the capital to the rest of Alaska, but there have been many prohibitive obstacles that stand in the way, namely cost and environmental concerns. As recently as 2014, there were proposals to build a 51-mile road (Dihle,2014). The road would have cut a path through one of the largest temperate rainforests left in existence as well as crossed five main salmon-spawning rivers. These areas are home to dense wildlife populations of wolves, brown bears, mountain goats, and moose. Building this road would undoubtedly have a damaging impact on these animals by an increase in auto accidents and the effect on migration patterns.

Even if the road system was built, there would need to be a new ferry building constructed where the road dead ends. The ferries would deliver passengers to Haines and Skagway which are the closest towns with road systems. As a result of building the road, one or two ferries would most likely be eliminated due to the diverting of financial resources. The Transportation Department estimates that over the 50-year life of a ferry, it will cost the state $1.72 million with marginal returns from passenger fares (Dihle,2014). It is projected that only

30 percent of the cost to run a ferry will be recovered (Dihle,2014). Ferries represent over half of the state transportation budget, yet account for only one percent of the miles serviced (Dihle,2014). Conversely, building the road and new ferry building is estimated to cost $523 million (Dihle,2014).

Even without building the road, the cost to survey the proposed route and environmental impacts has already cost $28 million (Dihle,2014). The proposed road would traverse migration paths which would increase vehicle collisions with wildlife. Additional challenges include the proposed road being in the direct path of 36 avalanche areas and mountainous cliffs (Dihle,2014).

Avalanches represent a challenge in Alaska due to the aftermath impeding logistics. There are two ways to reduce the risk of avalanches. One is to shoot mortars into the side of a mountain which preemptively shakes free loose snow to reduce the likelihood of an avalanche. The problem with this is that the geography of the area is such that there is nowhere to shoot the mortars into the avalanche path. Another option is to drop explosives by helicopter. This option isn’t feasible due to winter weather making flying impossible, often for weeks. The price of avalanche mitigation annually would be approximately $523 million (Dihle,2014).

With the exorbitant price tag associated with building and maintaining the proposed road, it is no surprise that the ferries, although costly to the state government, are the preferred form of transportation. The pragmatic approach to expensive options in a remote site are not unusual as operations cost more to provide goods and services to these areas.

Winter represents an opportunity for communities to receive assistance by truck which is much more reliable and less expensive than flights. Trucking is also not without its hazards. The

James Dalton Highway has earned a permanent position as one of the world's most dangerous roads (Monks,2015). This highway stretches 414 miles between Deadhorse and Fairbanks and is the only route and supply line to the Arctic Sea Oil fields (Monks, 2015). High winter winds in addition to 12 percent grades make this highway particularly treacherous (Koch,2013).

The state of Alaska also builds seasonal ice roads for remote villages to prevent them from being completely cut off from supply routes. In 2017, the Community Winter Access Project worked for two weeks straight to provide an ice road for the northern villages of Utqiagvik which has 4,500 residents and Atqasuk which has a population of 200 (DeMarban,2018). These roads are functionally useable from March to May. This is dependent on warmer temperatures and wetter weather that deteriorates the road. In an effort to prevent people from getting stranded, permits for transiting the ice roads are awarded to all travelers when minimum snow cover and frost depth is met. In addition, all travelers must join a slow-moving pilot car (12 mph) in a convoy, which leads vehicles along the highway (DeMarban, 2018). These convoys service villages along the highway once a week each way. This might sound a little sparse or extreme but it is better than being completely cut off from the world for a complete season. By utilizing ice routes by truck or car, residents can save money on expensive air and barge services. As an example, Shirley Kagak, a resident of Atqasuk, purchased furniture from Anchorage for $3,000. Shipping the furniture by plane would have cost her an additional $4,000 dollars, but instead, using a truck she saved in transportation costs $1,000 (DeMarban,2018). That represents substantial savings to communities on fixed incomes. Due to remote locations, everything costs more to ship and receive, but to save money on deliveries and have reliable service is important for the populations that depend on it.

Air Search and Rescue

Another critical service that the state of Alaska provides is search and rescue operations by helicopter. The state of Alaska currently maintains two helicopters specifically for search and rescue, Helo -2 and Helo-3. Highlighting the challenges of flying helicopters in Alaska one has to look no further than the fate of Helo -1. On a seemingly routine search and rescue mission, Helo-1 was deployed to respond to a snow machine injury. The mission was to rendezvous with an ambulance after the patient was picked up from the scene of the accident. Helo -1 never made it to the rendezvous point and crashed, killing two state troopers and the patient. After the crash, weather and reduced visibility were said to be factors in the crash. Losing Helo-1 was a devastating loss as an asset that is so critical for lifesaving operations statewide. Because Helo-1 had a capacity for five people and was a turbine powered Eurocopter AS350 with a range of 400 miles based in Anchorage, it was a critical asset. In 2012, Alaska Department of Public Safety purchased a new American Eurocopter AS350 B3e, later named Helo-3, for $3.2 million dollars to replace Helo-1; it has similar capacities and is now based in Fairbanks, Alaska (Shedlock,2013).

Helo-2 is a Robinson R-44, which are much smaller than Helo-1 and 3. Helo-2 and Helo-3 both fly about 150 hours a year (Shedlock,2014). Based on maintenance, fuel and stowage, Anchorage's Helo-3 costs the state $63,000 per year while the Fairbanks based Helo-2 costs $161,000 per year. In addition to operation costs, the pilot salaries account for $120,000 (Shedlock, 2014). The Robinson R-44 helicopters have reduced capabilities when compared to those of Helo-1 including air speed which affects response times (Shedlock,2013). They do, however, have advantages with missions tied to patrols, nearby missions and monitoring fishing operations.

The cost to charter commercial helicopters ranges from $1,500 - $2,000 per hour; however, traditional operating costs are less for search and rescue for the state due to not needing to make a profit (Medred,2016). Even with price breaks and discounts accounted for by the government, search and rescue budgets absorb $600,000 of the Alaska State Trooper budget annually (Medred,2016). Due to the remoteness of some areas in Alaska and the capabilities helicopters offer, search and rescue has been largely considered a government responsibility. For this reason, no one is ever charged for services related to search and rescue. To reduce expenditures to search and rescue operations volunteers typically comprise approximately 75% of all personnel involved (Medred, 2016). Alaska's search and rescue resources include over 1,100 volunteers at their disposal spread across the state (Alaska Department of Public Safety, 2018). They help with manpower and expenditures for over 450 search and rescue missions each year (Alaska Department of Public Safety, 2018). In addition to helicopters, the state troopers also have other aircraft, marine vessels, ground search teams, and canines. Each trooper is trained specifically for search and rescue operations and participates in exercises in each geographic area within the state.

Another part of the search and rescue equation is rescues that occur at sea. Commercial fishing is the second major industry, only to oil operations, which generates 60,000 jobs seasonally and 8,000 permanent jobs. During the fishing season, crews can encounter hurricane force winds and giant waves as high as 46 feet, which threaten the thousands of crews who work in isolated areas year-round. Due to adverse weather conditions and the amount of fishermen present, it comes as no surprise that search and rescue is so common. The United States Coast Guard (USCG) is tasked with the primary search and rescue for marine-based operations covering nearly 3.5 million square miles (Cohen, 2011). When the Coast Guard gets the call for assistance they endeavor to respond in fewer than 30 minutes (Cohen,2011). Captain Mark Morin of the USCG search and rescue team says it best, “Every time we get launched on SAR, we are the last line to rescue these people because there is no other game in town” (Cohen,2011). In addition to search and rescue operations, the USCG provides the main medivac resource for the state in responding to medical emergencies. Flying in Alaska has its challenges with heavy storms, thick fog, extended periods of darkness, and extremely cold temperatures that affect fuel viscosity which inhibits the ability to fly. Weather patterns around the Aleutian chain and the Gulf of Alaska consist of the warmer Japanese Current which meets the cold waters of the Bering Sea. This meeting of differing temperatures and pressures creates extreme winds, high seas, and heavy fog which can drag on for days or weeks.

Airports

In addition to weather conditions hindering air transportation, many rural villages depend on air transportation for medical resources. In fact, there are 201 Alaskan communities that have no road access to the nearest inpatient medical facility and 25 of those communities don’t have airports at all (FAA,2001). The average distance traveled to the closest medical facilities averages 147 miles (FAA,2001). Not having accessible inpatient services or specialized care is not unique to Alaska. In fact, many populations around the world do not have easy access to medical services; however, the sheer number of communities and percentage of the population that depend on aviation as the sole means of transportation for medical care make Alaska unique. These isolated communities account for 64,000 people which is ten percent of the population of Alaska (FAA,2001). With so many communities it would be impossible to have airports in every village so the Federal Aviation Administration helps to maintain 176 airports which serve these 201 communities (FAA,2001).

The factors affecting conditions at airports are runway length, surface and condition, airport lighting, weather reporting systems, communications, and instrument approaches. These are the factors that the FAA concentrates on when improving airports and deciding which villages are safe to fly to on a regular basis. The geography of an area plays an important role when building runways. The faster the approach speed, the longer the runway needs to be (FAA,2001). Heavier aircraft create large stresses on the runway and the need for a hard, well drained surface (FAA,2001). Depending on the layout and topography of a village, there may not be a way to adequately accommodate a runway.

Challenges also exist in the local infrastructure, affecting communications, weather reporting, and navigation aids- which all play a part in assessing needs and the feasibility of bringing an airport to a particular region. Recurring operating costs can often exceed initial installation and equipment costs by as much as 10 times (FAA,2001). In addition to high operating cost, the power generation of the village must be adequate to support communications. In most of these remote villages, the power generators are closely aligned with the power requirements of the village. Any increase in usage could overload the generator. Usually the local public utility passes on the cost of adding capacity to the user when requested. In most cases in Alaska, the FAA pays for the increase of capacity at highly inflated rates. For example, the airport in the village of Minchumina, which is one of the most remote villages in the state, costs the FAA $1.84 per one kilowatt (FAA,2001). Kilowatt hour rates usually cost $0.50 per kilowatt (FAA,2001).

Another necessary resource is a dedicated, continuously open phone line. These lines are essential for weather briefings and telecommunications with pilots as well as remote monitoring and system maintenance. This again can be very expensive as most villages only have one or two phone lines. For example, the phone line from Deadhorse to Fairbanks costs $5,000 dollars per month to maintain (FAA ,2001).

Although there are many challenges to flying in Alaska there have been some systems developed that make predicting weather more reliable. One of these system is Juneau Airport Wind System.

The Juneau Airport Wind System (JAWS) was developed by Alaska Airlines, the FAA, and the National Center for Atmospheric Research, and took 18 years to develop (Inbound Logistics,2014). This system was formally commissioned in 2012 and was created specifically for Juneau's geography, which often creates high winds and thick fog - making takeoffs and landings more dangerous. JAWS is an air turbulence system that alerts pilots about severe wind conditions at or around Juneau International Airport (Inbound Logistics, 2014). Additionally, recommendations for flying are given based on wind shear and turbulence date. Since Alaska Airlines started using JAWS it has had a flawless safety record since 2012 (Inbound Logistics, 2014).

Having systems to help predict weather patterns are invaluable to the flow of goods and services. However, rural villages must deal with other issues that are out of their control like climate change. Climate change driven weather patterns are much harder to predict, and really affect populations residing on barrier islands.

Barrier Islands

The people of Kivalina have lived at their traditional home on a barrier island bordering the Chukchi Sea, 83 miles above the Arctic Circle (Mooney,2015) for centuries. They hunted bowhead whales on the extended sea ice, however the sea ice that bordered their island has consistently receded. The ice used to be eight to ten feet thick and now it is too dangerously thin to hunt the whales on (Mooney,2015). The seasonal sea ice used to create a barrier around the island which prevented erosion, and now powerful waves wash across the village. There has been talk of moving the village more inland or further down the coast. The community consists of 85 houses, two water tanks, an airstrip, a post office, and a school (Mooney,2015). During President Obama's presidency, he proposed a federal spending bill to help native communities deal with climate change. Funds for the bill totaled more than $50.4 million (Mooney,2015). The reality is that these funds represent less than half of the projected cost of what it would cost to relocate Kivalina. What compounds the problem is that there are 12 other villages with similar relocation circumstances (Mooney,2015). The likelihood of moving one, let alone several villages is not financially feasible. Temporary solutions have been implemented to buy time, like building a rock erosion barrier in 2011 (Mooney,2015). This again illustrates the harsh realities of living in Alaska; tough decisions must be made and solutions are constantly evolving.

Food Storage

Another example of thinking outside the box is a food storage proposal. Due to the wide population distribution of the state, the bulk of emergency preparedness falls on individuals, then goes to the community level, then the state, and finally to the federal government. Many communities don't have a type of formal local government that interacts with the state on a regular basis. Regardless of participation in government politics it is the state's responsibility to provide assistance with food and water. In recent years, the population has become more dependent on store bought food due to limited access to goods. This is fine as long as the transportation of goods stays consistent and uninterrupted. However, if anything disrupts the supply chain, communities could be shut off and unprepared without emergency food supplies.

To combat this problem there was a plan developed called Alaska Community Emergency Food Cache System (Snyder,2017). This system is catered to preparedness on the community level to ensure everyone has enough food in the wake of a disaster. Starting in 2013, the state started developing a Strategic Catastrophic Disaster Food Reserve of Meals. This program was meant to create seven days' worth of food for 20,000 individuals in two separate locations: Anchorage and Fairbanks (Snyder,2017). These two cities were chosen because it was found that it was statistically impossible for these locations to suffer a natural disaster at the same time (Snyder,2017). In 2014, the program was discontinued due to state budget shortcomings. It is unfortunate given the benefit to the population in emergency situations. However, according to FEMA recommendations, a few weeks of food preparation is much more adequate as supply lines might not be up for weeks after a disaster (Snyder,2017).

The high cost of doing business and weather constraints are a challenging reality in Alaska. The people and companies which serve these communities have developed effective ways to work around these challenges and these lessons could be applied to other remote regions of the world which face similar difficult realities. Recalibrating supply chains to encompass different modes of transportation, and solutions catering to the challenge must be faced. A form of technology that has been emerging in the assist in logistics is through the use of drones.

Drones

In 1918, the first unmanned aerial vehicle (UAV), otherwise known as a drone, was called the Kettering Bug and was adapted to during World War One (Hunt, 2017). This technology was able to control the levels of speed and height remotely, essentially an unmanned flying torpedo with a range of 40 miles. This early drone was made of cardboard and required an aiming track to launch it. Since the days of the Kettering Bug, there have been substantial advancements, including features such as cameras, night vision and the ability to drop payloads of critical materials. Additionally, commercial drones have reduced in size while increasing speed and battery life. Initially, the drones were only allowed to be operated and constructed by the military; however, there has been a shift due to the many benefits that drones provide to many different markets worldwide. The advantages of drones include: humanitarian aid, medical emergencies, and rescue missions.

Drones in Alaska

Drones are used worldwide for a variety of different applications. It should be no surprise that Alaska has embraced this technology to solve many of its logistical challenges. As recently as 2017, the Alaska Department of Transportation was training to use drones for damage assessments (Lillian,2017). The use of aerial views for can be a lot more useful than information gathered on the ground. Some of the valuable information which can be gathered through aerial information involves closures to infrastructure including roads, bridges, or other structures caused by man-made or natural disaster means. An increasing number of Alaska State employees are adding drone flying to their duties because of the financial savings and the potential reduction in putting people in harm's way. In 2017, the State of Alaska finalized laws applying to operating drones. This allowed agencies who were interested in taking advantage of drone technologies to know what the rules would be and to incorporate them to logistical resources. Alaska operates 250 airports statewide which could all use drones for their local needs (Lillian, 2017).

An example of the projected savings would be in the case of a needed aerial survey to a remote region. The cost of using traditional means for the survey with an airplane can be as much as $100,000 (Lillian, 2017). By using a drone, the price of the same survey could be reduced to the price of the drone, around $2,500 (Lillian, 2017). With savings like this, more utilization by government and commercial uses will only gain traction in reducing transportation costs and speed up reaction times.

Advantages of Drones

Humanitarian Aid

Drones have a well-chronicled history of providing useful information to rescue teams in desperate need of information. Examples of how drones have been used in past disasters are with the damage assessments preformed in the Philippines after Typhoon Haiyan in 2013, and the Nepal Earthquake of 2015. Although information that drones provide from damage assessments is useful, the next step in drone evolution is to actually deliver aid.

An example of a drone which is equipped to deliver aid is the APSARA glider developed by Otherlab. This drone can carry up to two pounds of supplies, which could include blood, vaccines or other lifesaving items. This drone can be dropped out of a cargo plane and controlled by GPS or autopilot which help direct its descent. This drone is so precise that it can land as close as 33 feet from its intended landing spot.

Another useful option would be the Pouncer drone created by Windhorse Aerospace. This drone has components which are made of plywood that are intended to provide firewood in case the person in need requires a fire. Additionally, the wings are packed with food and water while the frame provides a temporary shelter. The food provided onboard is enough to feed at least 40 people (Windhorse, 2018). These three features would provide those in need a larger window for rescue given that remote sites can be difficult to respond to, and the drone could provide aid right away. Nothing goes to waste on this drone as everything has a form and function to provide aid to the party in need. The Pouncer can carry payloads of 50kg and be launched at speeds of 120 mph (Windhorse, 2018). The maximum range for release is from a height of 25,000 ft and it has a gliding distance between 35-40ft (Windhorse, 2018). Given the features of the Pouncer, it would seem ideal to respond to the challenges that Alaska faces. Time being critical in aid situations, this could be useful in Alaska with low temperatures and bad weather speeding up the necessity of response.

Challenges to Drone Use

Drone use has expanded worldwide as many countries look to embrace the technology to provide a way to get goods to the consumer. Unfortunately, the United States has passed legislation which has hindered the use of drones. The law that governs drone operation in the U.S. is Part 107. Under this law anyone who operates a drone must go through specific training which includes: passing an initial aeronautical knowledge test and obtaining a remote pilot certificate. The aeronautical knowledge test must be renewed every 24 months at a cost of around $300. There are over 700 FAA approved centers at which to take the knowledge test, which illustrates the popularity of drone use. Other requirements include being at least 16 years old, being vetted by the Transportation Security Administration (TSA), and being available for inspection and verifying proper paperwork is in order. Additional requirement include testing the drone to make sure equipment is functioning properly as well as owner familiarity in operating equipment.

Currently, countries all over the world are trying experimenting with autonomous drones which operate out the sight of the operator. Companies such as Amazon, 7-11, DHL, and Domino’s Pizza all make deliveries through drone technology internationally; however, the

United States has strict laws prohibiting the use of autonomous drones which operate out of the sight of the operator.

Laws are not the only prohibitive factors for drone operations. Battery or power source life is a primary consideration for any drone since this dictates its range and time of operation. The smaller the drone, the shorter the battery life and the reduced pay load capacity. Conversely, the larger the drone, the more battery life and increased pay load capacity. The energy source also dictates how high a drone can go vertically. In the United States, the maximum vertical life a drone can go is 10,000 feet.

Choice of Drones in Alaska

Alaska poses many challenges to logistics stemming from geographical to weather problems which end up making it hard to send and receive goods in a reliable manner. Most of the transportation modes put human life into harm's way to deliver necessary items needed for survival of remote communities. Drones present a way to prevent loss of life due to transportation accidents while providing a way to utilize existing technology. The sheer size of Alaska makes it virtually impossible for logistics to be consistent in areas that are remote and do not have adequate infrastructure to enable constant flow of goods and services.

Drones offer a way to operate in low visibility like fog and times of darkness. Continuing the flow of logistics in times of extended darkness are important for communities who have small time frames in which to accomplish their transportation needs to get their resources they so desperately require. With drones getting more and more sophisticated, night vision is a feature that comes standard on most drones. Night vison allows drones to operate a night and low visibility is conditions that would be out of the question for human pilots to fly in. This provides an opportunity for logistics deliveries 24 hours a day without restriction. By eliminating the danger to humans while increasing efficient operations to logistics, drones become not only a viable option, but a preferred method of support of logistical operations.

The Creative Project

The logistics in Alaska have been a persistent problem that have demanded a look at different options that may improve reliability and save lives regardless of the seasonal weather patterns and challenges to logistics. It is my belief that drones could be effectively used to provide food, water, and medicine in the short term to extend timelines for rescue personnel or commercial needs. Additionally, with regards to cost, drones could be a new way to deliver everyday goods in a way that is both cheaper and a better logistics option. I propose the use of drones through what I've labelled, "The Alaska Project."

Planning

During the planning stages of the Alaska Project, a combination of five sites spread out statewide will be selected to participate in the study. The sites will be chosen based on geography, challenging weather patterns and need of local communities. The sites will include Juneau, Whittier, Dutch Harbor, Fairbanks, and Barrow.

Juneau was selected due to its challenges to logistics that make it valuable as the state capital of Alaska. With frequent avalanches, the value of aerial recon would be worth its weight in gold. The shipping of goods by drone to a town that doesn't have any roads connected to it would be do a great deal in lowering transportation costs.

Whittier was chosen due to its hard winters and unique characteristic of having restricted access as there is only one road out of town. This road goes through a tunnel which cuts through a mountain. This mountain has been known to have avalanches which have closed the tunnel for significant time. The only other source of transportation out of town is by ferry which services the town.

Dutch Harbor was considered due to it being a location which has been a difficult place to fly into and has significant adverse marine weather making it a hard spot for boats as well. The effectiveness of drones would make deliveries more reliable as weather can hold up shipments for days, which is challenging for any isolated communities on the Alaskan chain.

Fairbanks was chosen due to its location deep in the Alaskan interior of the state. It is a good mid-point between the Polar regions of the rest of the state. It has a military base and airport which would be a good base of operations for drone repair and could take advantage of a lot of flights that take off frequently for launching the drones, which must be launched by plane. It is also one of six approved drone testing facilities in the United States. The other five locations are the state of Nevada, North Dakota Department of Commerce, New York's Griffiss International Airport, Texas A & M University and Virginia Polytechnic Institute and State University.

Lastly, Barrow was chosen as an optimal location for drone research because of its location as the most northern town in the state and being in a polar region. Drones which could service this area with reliable deliveries would be a great positive addition to logistics in the Arctic.

Preparation for operating and testing the drones at these pre-determined sites will have to have approval from the FAA with all operators and staff with the appropriate licenses. This will be an expense of at least $300 per person to fulfill licensing requirements. To minimize cost associated with the study, volunteers will be utilized whenever possible such as with search and rescue personnel which is predominately made up of volunteers across the state.

Working with the towns that the drones will be travelling to will be critical in establishing prepositioned landing spots as well as retrieval teams to gather and return the drones after they have made it to the destination. This will be critical in analyzing the data from GPS and autopilot trackers for future improvements. Additional information that will be gained is through preferred routes for seasonal weather patterns, wind, and low temperatures which minimize damage to the drones. There will be a reasonable expectation that some of the drones will sustain some sort of damage, especially in the early stages of the study. Spare parts and additional drones will be kept at a centralized location in Anchorage so there will be minimal delay in the case a drone needs to be taken out of service due to malfunctions or damage. Anchorage was chosen as the central site due to the frequency of air travel into the city, which is every day with minimal interruptions due to weather.

There are many drones being used for different forms and functions throughout the world so there had to be some sort of selection criteria to choose which one would best fit into logistics overall in Alaska. The criteria used in choosing drones which would best suit the logistics challenges were size, services provided, capacity, and launch capabilities. To provide vital information to the study the three drones selected were of varying size and scope.

The APSARA Glider was chosen due to the ability of this drone to be dropped out of an aircraft thereby eliminating the need for landing at an airport. This drone is the smallest model in the study, but still preforms an important job. The challenge of remote native villages essentially being cut off from the rest of the world during seasonal weather patterns could be reduced by the use of this drone. Even with such a small payload, receiving critical lifesaving resources like vaccines and blood can be the difference between life and death.

The Pouncer is the mid-size drone of the study which provides a valuable resource to search and rescue personnel. This drone was chosen due to the entire body of the frame serving a purpose so nothing goes to waste. It provides firewood, temporary shelter, and food for up to 50 people (Windhorse,2018). Since it can be launched by airplane or on the ground, it makes it versatile in many varying environments including low temperatures and marine climates.

The Freight drone is considered to be the largest of the drones in the study. The possibilities of reducing transportation costs while being able to perform reliable logistics operations make this drone very important. It has possibilities of carrying up to 90 lbs. of freight at a time with sizes varying with mission and payload.

Participants

The personnel who will take part in the study will be professionals in each of the desired professions which the drones will affect. For the APSARA Glider, staff will consist of those who have knowledge of medicine because this drone would be used for transport of blood, vaccines, or any other lifesaving payloads of two pounds or less. Other payloads of two pounds could also be attempted and substituted with the study. Knowledge from medical professionals about how to pack these drones to preserve the payload will be important. After all, it doesn't matter if the drone makes it to its destination if what it is carrying is ruined.

The Pouncer team will contain people who have a knowledge of ground and plane launched drones. This drone is a more complicated than the APSARA Gliders and can be relaunched, retrieved, and re-used. This will require a staff that can launch the drone and understand its operation. Search and Rescue teams will be utilized as most of them are volunteers and they will most likely be the ones who use this type of drone functionally. Feedback on its use it real life applications will be critical for the success of this drone as well as provide information for improvements.

The Freight drones will require a staff with knowledge of aviation requirements and geography of the area. In 2015, the FAA gave permission to companies to test these types of drones with restrictions. These restrictions included having that the drones had to stay in sight of the operator, remain under 400 feet, and testing could only be done during daylight hours.

Working with the FAA, state of Alaska, and local governments will be instrumental in furthering these tests in Alaska. Other possible partners that this project could benefit from working with are commercial freight companies who have done testing in other states and abroad and NASA. NASA was brought in for a similar freight project in Virginia which delivered medical supplies to a remote Virginia town. This project was a success as medical supplies were delivered to a rural clinic in southwest Virginia (Pepitone,2015).

Staff Development

The staff will include one representative for each respective drone who will be responsible for monitoring data. Each drone expert will be tracking information such as the success rate of making it to the destination, feedback from those who are launching the drones and from the recipients. Regardless of position, each staff member will need to have the proper drone license so that team members can be interchangeable, if needed. The staff will be kept small for the initial phases to keep operation costs down but accommodate for further expansion, if necessary. Possible expansion of drones of different types in the study and bringing in of outside consultants could happen with government grants or financing from commercial interests.

Each drone staff member will be responsible for understanding and analyzing the data for monthly review meetings to see how the drones are measuring up to expectations and what, if any, improvement could be made for the next launch.

Additional personnel which will be brought in will be the personnel who can provide expert advice in the areas of interest. The APSARA glider will get information from medical professionals who will give feedback at how to best pack and transport blood and vaccines for their small payloads.

The Pouncer’s consultants will be from the search and rescue resources who can provide feedback on the drone’s use in real world application. Working in conjunction with these professionals will help to see if any alterations need to be made or the functionality of launching and retrieving the drones was needed.

The Freight drone would include a staff that will be consist of outside contractors who have knowledge of similar drones or projects around world. This is due to limited testing in the United States which limits the wealth of drone testing experience within the country.

Methods

Deployment methods would differ for each drone to diversify the sources of infrastructure that could be utilized. The APSARA Glider would be launched by passing cargo planes that are travelling over or near the desired area. Other types of planes or helicopter could be utilized as long as they could be launched successfully and without hindering safe navigation. Retrieval of the drone could possibly be mailed due to its size or picked up monthly during the study.

The Pouncer can be launched off a plane or from the ground. This is gives flexibility to diversify launch points and find out if there would be a preferred method to each of the locations. This drone’s retrieval method will most likely some sort of vehicle like a pickup truck or van. Due to the weight of the drone, it limits the retrieval options. There will be an equal amount of testing from each launch point to have a good swath of data from each location.

The Freight drone will be launched from predetermined sites on the ground. This will minimize transportation costs associated with launching drones. Testing these drones in Alaska will have to follow the rules like staying under 400 feet and flying during only daylight hours.

Working with government agencies will most likely offer an exemption for the study which will prove invaluable. There would be valuable information gained by night operations due to colder temperature and winds that increase once the sun goes down. The freight drones, once in the sky, will have tracking information and camera relayed back to central operations center in Anchorage.

Equipment

The Alaska Project will include three different kinds of drones. They will vary in size, load capacity, and mission. The drones that will be used will be: APSARA Glider, the Pouncer, and the freight delivery drone.

The APSARA Glider will be used for small deliveries with payloads of two pounds or less. Due to the size of this drone there will be more on hand than the other drones. The mission of these drones will be to deliver blood, vaccines, and medicine to remote regions.

The Pouncer will be used in conjunction with search and rescue operations to offer support to those injured, stranded, or in need of assistance until help can arrive. It weighs 50 kilograms fully stocked and 25 kilograms empty (Windhorse, 2018). An advantage of this drone is that it can be launched back to the point of origin if there are properly trained personnel to do it.

The Freight drone could carry a payload of 50 pounds. Its mission is to deliver its payloads to remote areas and urban areas alike with a more efficient timeline than more conventional means of delivery.

In addition to the actual drones, equipment that will be needed is laptops to keep the records of all flight data. Comparing the data of each of the drones to find the successful launches and flight paths will all require appropriate software. Other equipment needed will be GPS tracking and night vision equipment.

Launching and retrieving vehicles will have to be contracted out for the Pouncer especially. Those modes of transportation will most likely not be needed for the APSARA Glider and Freight drone.

Timeline

The timeline for the Alaska Project will be conducted over a two-year period with annual performance evaluations. This will allow for baselines and improvements to occur with a possible extension to five years if financial resources remain. There will be monthly and yearly meetings to accumulate and review the data that from drones.

All of the drones will be launched at least once a month to obtain data for every calendar month and account for seasonal weather and provide a baseline for every month. This will be valuable information for comparison. There will not be a standardized schedule for the launches of the APSARA Glider and Pouncer due to every drone depending on flight schedules. The Pouncer will have more latitude for testing due to the ability to be launched from the ground as well. The Freight drone will be launched dependent on its ability to receive the pay load and prevailing weather conditions.

It is expected that the first couple months might be slow due to preliminary launches and personnel getting used to the drones and software used. It is expected that in the early stages of launching that the drones that might not be equipped at least initially for Alaskan weather. Since the study will begin in January, this will be the middle of winter which creates its own challenges of cold weather and high winds.

Given that the launches will only take place once a month; this will provide time to work out bugs, repair the drones, and give adequate time to set up ideal situations for launches. It is expected that within a couple of months, there will be a reasonable standard of operation of the drones. This should continue the timeline without any delays. There will be unexpected delays but there is enough buffer within the timeline to not significantly affect the timeline.

Implementation

The implementation will begin slowly initially with one launch of each drone per month due to cost. Launches will occur year-round but the months that will be critical to keep in mind will be during winter as this is when the most adverse conditions for flying and marine traffic occur. Winter in Alaska starts around November and continues through February which would make this time frame increasingly important to the study.

The implementation includes one launch of each drone per month which is slow enough initially to phase these drones into operations of the state services. The pre-planning will be critical to an easy transition to include drones into their operations. A clear understanding of the responsibilities of each party and what the agreement is to incorporate drones into regular operations.

The APSARA Glider’s implementation will include contracting with cargo planes to drop the drones. This will probably be the easiest out of the three because all the contractor has to do is drops them out of the plane and the drone team does the rest.

Pouncer’s implementation will be more complicated due to it being incorporated into the search and rescue operations that are already established. Once it proves to be a valuable resource to the department, implementation can be phased in at a faster rate. It won't take long to assimilate this drone into search and rescue given its positive take away that give these teams more time to save lives.

The Freight drone will be easy to implement due to commercial companies most likely wanting to be onboard to a market that wasn't open before. Alaska has been traditionally a difficult place to send and receive goods and services. With the success of a reliable delivery drone in Alaska there would be a long line of potential investors. The speed of implementation would be the fastest out of the three drones due to the variety of applications that this drone would fulfill which would extend from humanitarian efforts to commercial operations such as delivering packages.

Assessment

Critical information that will be measured will be accuracy to landing spots, any damage sustained to drone or cargo, and any difference in operations during seasonal weather patterns including performance in low temperatures. With technology being tested in areas that there is not any information available about there must be a baseline setup so that there is some type of baseline where similar months and conditions can be compared. This is why every month will have a launch so year one can be compared with year two.

A major component for the assessment will be through feedback from the parties who use the drones. In order to improve designs, function of the drone, and easier launching, feedback will be obtained from the personnel. These are the people that use these drones frequently and will know the idiosyncrasies of the device.

Information will need to be gathered as to how the drones function in the different locations and during different weather patterns. Baselines for these factors will be important for assessing how good of a job the drones are preforming.

An easy metric to measure will be to how close the drones make it to their desired location. Another assessment that will be measured will be if there is any damage sustained during operation and to what percentage it damaged. These quantifiable measurables will be vital in gaining additional funding for the study as well as additional partners to continue the research. Another measurable which is simple to look at is whether the drone successfully accomplished its mission and did the pay load land intact without any damage.

Conclusion

Alaska faces many challenges in providing logistics to its remote locations that demand unique solutions. Acceptance of these solutions are dependent on many factors including financial resources, government support through relaxed regulation, and how they are received by the communities which are affected. Widespread use of drones is not only important to the expansion of its use for logistics but can create other ideas or methods which can be built upon to improve logistics as well. Alaska provides examples of how remote sites can deal with challenges to logistics and provides out of the box thinking that can be applied to others within similar situations. Building upon the success of drones being used in Alaska, logistics can be improved by reducing transportation costs and making the delivery of goods more reliable. The use of drones as a clearly viable option will increase in Alaska as they have proven to be a solution to areas of difficult logistics.

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