HOW MUCH DOES A MAN COST?
A DIRTY, DULL, AND DANGEROUS APPLICATION.

By

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Abstract

This study illuminates the many abilities of Unmanned Aerial Vehicles (UAVs). One area of importance includes the UAV's capability to assist in the development, implementation, and execution of crisis management. This research focuses on UAV uses in pre and post crisis planning and accomplishments. The accompaniment of unmanned vehicles with base teams can make crisis management plans more reliable for the general public and teams faced with tasks such as search and rescue and firefighting. In the fight for mass acceptance of UAV integration, knowledge and attitude inventories were collected and analyzed.

Methodology includes mixed method research collected by interviews and questionnaires available to experts and ground teams in the UAV fields, mining industry, firefighting and police force career field, and general city planning crisis management members. This information was compiled to assist professionals in creation of general guidelines and recommendations for how to utilize UAVs in crisis management planning and implementation as well as integration of UAVs into the educational system. The results from this study show the benefits and disadvantages of strategically giving UAVs a role in the construction and implementation of crisis management plans and other areas of interest. The results also show that the general public is lacking information and education on the abilities of UAVs. This education gap shows a correlation with negative attitudes towards UAVs. Educational programs to teach the public benefits of UAV integration should be implemented.

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Literature Review

1.1 Definitions

This research uses ‘crisis’ to refer to anomalies in the natural disaster category, such as floods, fires, mining industry accidents, search and rescue efforts, and earthquakes. A crisis refers to ‘industrial accidents’ such as explosions, spills, and toxic fumes. A crisis, by definition, is chaotic and unpredictable and therefore difficult to plan for (Mileti & Sorensen, 1990). This research does not discuss intentional events, such as terrorist attacks, workplace violence, or public shootings. Also, crisis communication within the context of this investigation refers to risk communication as a part of a larger management issue. Risk communication is defined as any purposeful exchange of content between parties regarding matters, such as decisions, plans, policies, and other actions aimed at managing risks. Typically, this term is used to discuss adverse outcomes and the probability of that outcome occurring (Lang, Fewtrell, & Bartram, 2001; Jacks, Davidson, & Wai, 2010).

The goal of this research is to identify crisis management areas that can benefit from the use of UAVs and to help implement a plan that will make such uses practical. One current problem with using UAVs in crisis management is the difficulty of testing in real-time situations. Another problem area involves identifying best practices for procedures and communication patterns (Seeger, 2006; Hoorn & Pontier, 2008; Dautenhahn, 2008). Other problems include safety and ethics. It would not be safe to begin testing UAVs in real-time scenarios because this could be harmful to a person in need of a time-sensitive rescue. Multiple ‘worst case scenario’ plans need to be drafted and finalized, tested with UAV constructs, and refined to ensure that this technology is safe and efficient for crisis management use.

1.2 UAVs and Crisis Management

Previous research has investigated the possible uses and probabilities of UAV use in specific types of crisis situations. Natural disaster and industrial implications include the ability to map wildfires, survey natural disaster damage, and gauge radiation levels (Culver, 2014). Research also investigates wildfire mapping, SAR constructs, and the ability to topographically depict areas. These capabilities are especially valuable for the planning and execution stages of crisis management.

The ability to map wildfires is of importance because UAVs are able to fly into smoke-filled air, a dangerous endeavor that many times manned vehicles are unable to do. UAVs also have the ability to provide first responders with time sensitive information via sensors that could save time, money, and ultimately lives. The video, heat sensing, and mapping abilities of UAVs can also provide information about hot spots and sources of the fire, and also allow information on whether or not residents need to be evacuated from their homes (Boccardo, Chiabrando, Dutto, Tonolo, & Lingua, 2015; Drones as Lifesavers, 2014). The mapping and sensor ability of UAVs is also influential in flooding and landslide displacement scenarios. When dealing with wildfires, floods, and landslides it is essential to map out a large area to determine the damage and get visuals to decision makers in order to allow them the information to make the best course of action possible (Boccardo, et al., 2014).

Another area of literature regarding UAVs includes search and rescue (SAR) applications. SAR has been defined as "the process of finding and assisting persons who are lost in remote wilderness areas" (Goodrich, Morse, Engh, Cooper & Adams, 2009, p.453). UAVs assist in this area by accelerating the search process by allowing a 'birds-eye-view' of an area of interest and also by coordinating with the ground team. UAVs may reach and search areas that a manned helicopter may not be able to reach. Usually a member of the ground search team locates the missing individual via video from the UAVs, but with increased technology, UAVs would be able to independently locate a missing individual (Graham-Rowe, 2010; Reilly, Solmaz, & Shah, 2013; Martin et al., 2012; Mardell, Witkowski, & Spence, 2014).

The field of mining is another division of SAR that UAVs and Unmanned Ground Vehicles (UGVs) can provide assistance with. Mining has long been known as a crisis and risk prone industry inflicted with fires, combustion, structural failures, and dangerous gas leaks. The use of the unmanned technology can help detect when gasses are present and find problem areas without the need for a human body to be present. This significantly reduces the amount of risk and hours that human lives are involved in an area of high short term and long term risk. (Charlebois, & Elliott, 2009).

Other areas that UAVs can benefit include geography and ecology. UAVs are able to be more mobile, reach areas manned flights cannot, and are more reticent than manned aerial vehicles. This means UAVs can be used for mapping fauna in bodies of water, creating time series of tree species, monitoring volcanic activity, monitoring coastal erosion, and monitoring and restoring cut-over bogs. (Kimantas, 2014; Husson, Hagner, & Ecke, 2014; Lisein, Michez, Claessens, & Lejeune, 2015; Williams, 2013; Inoue et al., 2014; Hodgson, Kelly, & Peel, 2013; Knoth, Klein, Prinz, Kleinebecker, & Goslee, 2013; Klemas, 2015; Carrivick, Smith, Quincey, & Carver, 2013).

This also allows UAVs to be viable for tasks such as monitoring crops and vineyards, weed management, 3D monitoring of plantations, and measuring terrain runoffs. The quiet technology even allows for close view monitoring of endangered species and spawning rituals. (Hassan, Lim, MatJafri, & Othman, N 2010; Baluja et al., 2012; Torres Sánchez, López Granados, De

Castro, & Peña Barragán, 2013; Barreiro et al., 2014; Kimantas, 2014; Torres Sánchez, López Granados, Serrano, Arquero, & Peña, 2015). Apart from monitoring environmental aspects for research or convenience purposes, literature also claims that UAVs are ideal for environmental crisis management constructs (Florin, & Sorin-Gabriel, 2011; Jones, 2014) and archaeology implementations in order to best preserve history while also discovering it (Smith, Passone, al-Said, al-Farhan, & Levy, 2014).

Other found uses of UAVs include inspection and surveillance of critical infrastructure constructs. UAVs are able to measure paved and unpaved roads and show surface distresses that need to be addressed. This could be a large asset, reducing many labor hours and hazards associated with instable infrastructure (Zhang & Elaksher, 2012). Bridges also need to be regularly inspected. This process can be cumbersome and risky. Using UAVs to visually inspect the bridge allows for a quicker and safer inspection. This concept is similar for railroads and power line inspections. Other transportation route inspections could also utilize this technology.

1.3 Strengths and Weaknesses

Other research illuminates strengths and weaknesses of UAVs in search and rescue simulations. One such strength includes the evidence from previous research that the more experienced and familiar a crew is with one another, the better the results (especially in search and rescue aspects) in finding subjects and for reducing the time to find subjects (Cooke, Gorman, Duran, & Taylor, 2007). Some weaknesses include limited range of communication from UAV to UAV or to the UAV controller (Choi, Nam, Shon & Choi, 2013). Areas for advancing these areas are under way, but not yet perfected (Dalmasso, Galletti, Giuliano & Mazzenga, 2012). Another weakness includes the lack of information on how best to communicate between video analysis and ground searches--including difficulty to provide real-time coordination. Other areas of necessary improvement mentioned in journal reviews include the need for UAVs to have the technology to be able to land and operate in dense and various geographical regions and to increase both electronic communication technology and ground member communication methods and protocol (Goodrich, et al., 2009).

Another weakness, or moreover a threat, is the possibility of technology used for nefarious purposes. For example, there is a possibility of UAV technology being used by terrorists to initiate an attack (Pikner, 2012). As previously noted, this research will not be focusing on the 'intentional' crisis aspects, but it is important to acknowledge any developments that could come about with UAVs and contemplate the possible threats that come along with advancing technology. Among these threats is the concern over privacy rights. Overall, those who are not directly in contact with UAVs are fearful that UAVs with camera capability will be used to spy on neighbors or other unwilling subjects. There are laws regarding UAV use, but enforcement is problematic and inconsistent (Butler, 2014; Pomeroy, 2015). Another potential concern is related to military UAVs warfare. Military bombings and 'drone' attacks are common associations among the public and reinforce the idea that UAVs bring death and destruction. Lawmaking efforts and Federal Aviation Administration (FAA) regulations may reflect this (Boyle, 2013; Strawser, 2010). In contrast, UAVs have also been employed as peacekeepers. For example, the United Nations (UN) is using UAVs to keep peace in the Democratic Republic of Congo and to build sovereignty in the war-torn area (Piiparinen, 2015). In general, UAVs can also serve as peacekeepers and empowerment tools for the general public against larger groups of power such as the government, or in social movement efforts (Choi Fitzpatrick, 2014).

Laws and regulations established by the FAA are also a limitation for many researchers looking to use UAVs and companies seeking UAVs as part of their logistical planning. The issues on lawmaking seem to be fairly divided. Some argue the laws put in place so far are not strong enough, and others plead for more freedoms to utilize UAVs in a manner that fits them best. (Nichols, 2014; Pomeroy, 2015; West, 2015).

Previous research also details some of the current technical limits of UAVs to fulfill crisis management needs. Some of these technical limits include payload, or how much weight a UAV is able to carry, visual/camera limitations, and battery lifetime (Parasuraman, Cosenzo, & De Visser, 2009). Current research suggests future studies contribute to the crisis management and UAV technology fields by improving access to visuals/ enhanced video in the field, improving the communication interface between ground crews and UAV-based crews, and creating a more sufficient way to model missing persons based on the visuals the UAVs can capture (Goodrich, et al., 2009).

Additional areas of the literature detail the technical aspects and engineering capabilities, limitations, and progressions of UAVs. These aspects include topics such as memory sensing and path planning for missions (Roberge, Tarbouchi, & Allaire, 2014; Xiaolei, Yanfang, Weiran, & Naiming, 2015), task collection and allocation, complementariness of different UAVs, autonomy (Maza, Caballero, Capitan, Martinez-de-Dios, & Ollero, 2011), and transmission delay issues (Armah & Yi, 2015). Other aspects collectively include parameter detection and identification techniques, spatial navigation methods, and altitude feasibility testing, and UAV deployment methods (Bhandari & Colgren, 2015; Chao, Guorong, Jianhua, & Shuang, 2015; Martin, Beyrich, & Bange, 2014; Xiaolei, & Hongmin, 2011; Lee, H. S., Yoo, &

Lee, B. H., 2015). Engineering constructs and the more technical side of UAVs will not be covered in-depth in this paper.

Some literature also relates to UAVs but is not UAV specific. There are multiple components that go into and onto UAVs to make them more mission capable. These components include accessories such as a variety of sensors and camera types. Research conducted on these accessories is summarized at the Workshop on Situation Management (Jakobson, Lewis, Matheus, Kokar, & Buford, 2005). Sensors are arguably one of the most versatile and important components for professional use of UAVs and advances in the field of remote sensing continue to expand (Dong et al., 2014; Klemas, 2015). Global Positioning Systems (GPS) also are in need of improvements when using UAVs for emergency management and other fields (Jin Hyo, JiWook, & Jiwon, 2014).

1.4 Research Questions

Formal research documenting the general publics' attitudes about UAVs overall is lacking. One previous study does illuminate responses from participants being exposed to one news story depicting UAVs used in military attacks in Afghanistan. The UAV exposure in this study was minute, and the results were focused more towards attitudes of political figures and platforms (Rowling, Sheets, & Jones, 2013). Research regarding multiple practices of UAVs needs to be completed, and research needs to be collected on attitudes towards these various uses. An important part of discovering and understanding attitudes would be to gauge the amount of knowledge the subjects have regarding the topic. There is also a lack of information on how professionals in the UAV world view their work and their relationship with the public. This investigation contributes to the existing literature by investigating knowledge and attitudes of the public regarding UAVs and their uses.

RQ1: What is the knowledge base of the general public for UAVs?

RQ2: What is the general publics' attitude towards UAVs?

RQ3: How do professionals in the firefighting, mining, crisis management, and UAV professionals view the use of UAVs?

RQ4: Is there a difference in attitudes between the general public and UAV professionals?

RQ5: Is there a relationship between knowledge of UAVs and attitudes towards UAVs?

Methods

In order to answer these questions, I needed to access two groups of participants (as well as access to UAV technology). Professionals in the UAV, mining, firefighting, police force, and emergency management fields were placed in Group 1, which consisted of nine participants. Members of the general public were placed in Group 2, which consisted of 99 participants. Access to UAVs and UAV professionals were procured through the Engineering Department at the University of Alaska Fairbanks (UAF) as well as the Geophysical Institute of UAF. The Alaska Center for Unmanned Aircraft Systems Integration (ACUASI) also assisted in recruitment efforts. Safety and UAV professionals were contacted from the Pogo Mines, UAF's police and fire station, and from the Center for the Study of Security, Hazards, Response and Preparedness (C-SSHRP). Potential participants were recruited via email. Snowball sampling was also used to solicit respondents.

Inclusion criteria for group 2 included the following: 1.) Subjects needed to be over the age of 18, and 2.) Subjects needed to live in the Fairbanks or North Star Borough area. Since the interviews were conducted with professionals in the Fairbanks area, or with a tie to Fairbanks, it was appropriate to take subjects from this area for Group 2 as well. The majority of survey participants were recruited from undergraduate classes at UAF. Instructors offered extra credit for participation in the study. A more representative sample of the population was desired, but due to time constraints and restrictions on where surveying may be completed, that was not possible. Due to those constraints, a subsection of the general population that would be considered educated was targeted. It can therefore be assumed that the knowledge portion of the survey will be higher than it would for a more representative sample.

To answer RQ1 (*What is the knowledge base of the general public for UAVs?),* Group 2 participated in an online survey hosted through Qualtrics. The survey consisted of the qualifying questions, a knowledge inventory, a personal involvement with UAV inventory, an attitude towards UAVs inventory, picture-based questions on UAVs, and basic demographics. The knowledge inventory portion consisted of questions about UAV in general and their uses, capabilities, limitations, and laws surrounding UAVs and their use. The questions consisted mainly of True or False questions with the occasional multiple choice and open-ended questions. The knowledge portion of the questions was scored, but all other questions unrelated to knowledge were not included in the score. These scores were given immediately to participants once they were finished with the survey; moreover, they were able to see which questions they answered correctly and which questions they answered incorrectly. This was done with the purpose of educating the general public. Instead of just gauging the knowledge level, the researcher wanted to take advantage of the opportunity to educate participants. The knowledge questions were scored cumulatively using functions built into Qualtrics.

To answer RQ2 (*What is the general publics' attitude towards UAVs?*), the survey included a Likert Scale gauging participants' feelings towards UAVs, UAV uses, and UAV laws. These questions also ask about the legality of UAVs and personal responses to privacy and endangerment statements. The options for each statement were ‘strongly agree’, ‘disagree’, ‘undecided’, ‘agree’, and ‘strongly agree’. As a way to insure integrity, participants were also asked about previous experiences with UAVs. The survey asked participants about previous experiences with UAVs in both leisure and work activities. The survey also had a ‘select all that apply’ question that sought to find out if the participant had been employed or was currently employed by fields that can be involved with UAV use. The rationale being that those with more experience with UAVs will have a more positive attitude towards them and be more knowledgeable about UAVs.

In order to answer RQ3 (*How do professionals in the firefighting, mining, crisis management, and UAV professionals view the use of UAVs?*), Group 1, professionals, was given the same survey as Group 2, general population so that certain experiences could be captured along with the attitude Likert scale and knowledge test. Researchers predicted Group 1 would be more knowledgeable and have a more positive view of UAVs because of their professional experiences. To further explicate RQ3, the researcher conducted semi-structured interviews to learn more about the use of UAVs in crisis management . These interviews ranged from 20 minutes to one hour depending on the relevance of the questions to each professional. Interview questions were centered on gathering information about professional experience, limitations, benefits, and amount of public involvement. Professionals were given the option to fill out the survey in person via a paper copy, or complete the survey online at a different time depending on time constraints and distance of the participant (multiple professionals’ interviews were conducted via phone). Interviews were audio recorded and transcribed.

The interview transcriptions resulted in 88 pages of data. Thematic content analysis was used to analyze the data and identify key ideas, commonalities, and categories to address the research question. The coded themes were established by frequency of occurrence, similarities, and powerful or unique statements (Owen, 1984). The themes are discussed in the results section of this paper along with representative quotes to illustrate each theme.

Comparing results from Group 1 and Group 2 was also an integral part of answering RQ4 (*Is there a difference in attitudes between the two groups?*). The results from both groups were compared based on test scores and the attitude Likert scale results. This comparison was also necessary to answer RQ5 (*Is there a relationship between knowledge of UAVs and attitudes towards UAVs?*). The hypothesis was that there would be a positive relationship between knowledge and attitudes.

Results and Discussion

RQ1 (*What is the knowledge base of the general public for UAVs?*)

The mean score on the knowledge portion of the survey distributed to Group 2, general population, was determined to be 21.33%. In contrast, the mean score from Group 1, the professionals, was 76%. This shows that there is a significance in difference between scores with the two groups. It is expected that the experts who have experience with UAVs would score higher, but this is a major educational gap. When prompted with the question 'Do you now what a UAV is?' 54% of participants answered 'no'. When prompted with the statement 'I believe I am well informed about UAVs.' 53% of respondents answered either 'strongly disagree' or 'disagree' with 29% of respondents answering 'neither agree nor disagree'. When prompted with the statement 'I believe I am well informed about laws and regulations pertaining to UAVs' only .08% of participants answered 'strongly agree' or 'agree'. With this information it is clear that at least half of survey takers were forthcoming about their lack of knowledge in these areas.

RQ2 (*What is the general publics' attitude towards UAVs?*)

Throughout the survey it is apparent that the number one use the general public knows UAVs to be used for are associated with the military and war. As was mentioned earlier, there was a study done regarding somewhat attitudes towards UAVs in military practices. This study, however, focused more on the attitudes of political figures and platforms and did not focus as much on actual UAV attitudes. When given five images of five different types of UAVs and asked 'which one are you most familiar with?', 43% of the participants selected the picture of the militarized UAV. One of the questions answered abnormally high by the participants included 'True or false: UAVs are currently used for military air strikes' in which 82% of respondents answered correctly. In addition, in the open ended questions such as 'what is a drone?' and questions about UAVs in the news or media, many responses involved military drones and UAVs used for air strikes and as weapons. In a statement on the survey stating 'I believe we should be able to use UAVs for military air strikes', the results varied with a mean of 3.48. It is therefore unclear if the public has a favorable or unfavorable view about UAVs being used for military purposes, but does show that when 'talking UAVs' many people think of it as a military application.

Another clear negative association with UAV use that the general public has is between UAVs and spying. When given the statement 'I believe UAVs are a threat to privacy' 47% of answers consisted of 'agree' and 'strongly agree' while only 12% answered 'strongly disagree' or 'disagree'. In addition, they were asked 'I believe the government uses UAVs to spy on citizens' and the results varied with more agreeing answers that disagreeing answers, but with the majority (51%) of answers being 'neither agree nor disagree'. It is clear from open-ended responses that the association between UAVs and recording, cameras, and videos are associated. When asked what a drone was, 15 of the 97 responses were related to UAVs being a way to record, take pictures and videos, and used for surveillance (not all of the 99 participants answered this question). Some of the most powerful responses captured include the following statements:

- "A small flying plane that can either record or cause destruction"
- "Something that flies in the sky watching"
- "Remote control plane with camera and spying capabilities"
- "A flying device used to survey, spy, or other military purposes"
- "A robot used by the government to spy on people and kill them"

It is evident that there is a fear or UAVs being used for spying on citizens. The ominous 'thing' in the sky that is 'watching' their every move. There is fear of the government not only using UAVs to spy on citizens, but also a fear of UAVs being used to kill citizens and 'cause destruction'.

RQ3 (*How do professionals in the firefighting, mining, crisis management, and UAV professionals view the use of UAVs?*)

The professionals in Group 1 overall had a highly positive attitude towards UAVs and their many uses. This was prevalent especially when speaking about the benefits UAVs bring to theirThree themes emerged related to the uses of UAVs: Individual lives, to their organization, and to the public. Some reoccurring themes…to their own life included categories such as safety, self-actualization, financial and work assistance.

2.1 Individual

Safety was mentioned on the individual level as well as on the organizational level and on a community-wide level. These participants felt more comfortable knowing that first responders have access to this information, and in many cases, know their lives will be in greater danger without the assistance of the UAVs. One participant explained, “They’re a benefit to me because I feel safer knowing that the first responders can do their jobs”. These individuals that know how UAVs can assist or even save them, feel they have more peace of mind whether they be on or off the job. This can pick up morale and make them feel more appreciated as employees. This also offers peace of mind knowing that their colleagues, friends, and family members are safer.

They also received self-actualization and enjoyment from their work with UAVs. When asked about the benefits they received as individuals many commented that it provided them with “intellectual stimulation” and that they enjoyed “the challenge” and one professional commented that “I get paid to play”. Another participant reflected on the question and came to life when answering, “it’s really exciting to be on the ground floor of an emerging industry and no matter what I do I can pretty much guarantee that I’m the first to do it. I’m looking forward to the day I can look back and say this is what I was doing. This is what we provided.” The ability to feel as though they are contributing to future generations and making their mark on history motivates many of them to work with UAVs. There are also the financial rewards. UAVs have provided opportunities for many jobs, and more importantly, careers. Comments such as “it is our livelihood” were common during interviews. Having access to UAVs also makes their livelihood more convenient and resources more accessible. One expert explains, that access to UAVs “provides imagery and data that would be impossible or difficult to obtain otherwise." The ability to collect the informational resources necessary for their job advances multiple fields more quickly and with less associated risks.

2.2 Organizational

Access to more accurate information was also mentioned as a benefit that their respective organizations receive from the use of UAVs in addition to it being a personal benefit to help them on the job. This concept was echoed again with "It's just a better overall operations when you can collect that better data-collect that more accurate data" and more on a micro level with, "results no longer personally interpreted and then orally passed on. Now UAVs can send data to command center and everyone can interpret. There's no human pre-judgment or pre-interpretation of the data" which makes the information more reliable. In many in these professional fields, more accurate information can be the difference between life and death.

Other benefits the organizations receive are prestige and good reputation. One member explained that it "provides us as one of the experts globally and specifically in arctic research. It allows us to become a world leader in the use of this technology for science" and another echoed this concept with "we have definitely improved the university's reputation in terms of being able to do remote sensing and remote observations" as a benefit. It was also discovered that the University of Alaska Fairbanks is one of only six test sites in the United States for UAVs, which helps the seemingly rural and distant university become more relevant and taken more seriously. This, as imagined, also helps with receiving grants and gaining money for establishments and universities involved with UAVs and UAV research.

Financial benefits are an important area as well, especially for establishment that ultimately exist for monetary gain. "We're bringing in overhead which brings money into the university" and "we are training students. We're producing graduates to stay in the state in high tech jobs which causes the state to be pleased with us and provides potential future donors." Not only does this research bring in money in the form of grants, but there are long-term financial 'wins' from these programs as well. Students are excited about technology and having the same fulfilling feelings in their life and work that these professionals have already achieved. This makes more students interested in an area that is sometimes difficult to get students excited about and ultimately finishing their programs. This also entices them to continue working with the university beyond graduation and becoming benefactors of the company. This means the state of Alaska also benefits from advances in technology and with the struggle of keeping skilled human resources within its' borders.

This leads to possibly the most important cost benefit ratio received from UAV use -- human life. How much does a man cost?

- "What's the cost of a man or a human's life?"
- "Being in there, in the conditions that you encounter in the mine rescue are one breath could kill a man"
- "Cost benefit is more so in the reducing the hazards to human lives is the biggest benefit."
- "Life and some financial, but life-life is what's really saved. If it's dirty, dull, or dangerous."
- "Cost when equating what you would expend on a UAV, you might expend on putting somebody's life in harm, I mean there's no questions in terms of the cost benefit analysis on that."

It is clear that the most valuable benefit of UAVs is the potential to save human lives. When equating finances to a human life it seems the interviewed participants always compare it not with numbers, but with a question. This, in our opinion, is because it would seem there is no amount of money that would be sufficient to pay for a life. This makes the cost of a UAV in comparison to the cost of a life look miniscule. It a few interviews it was mentioned that UAVs are not always the most cost efficient financially in all situations, but when it is considered to be 'dirty, dull, or dangerous' then the cost in incomparable. This saying means that if the situation is in any form a threat to human life-whether it be first responders, researchers, or pilots -- that it is crucial that UAVs be utilized. The inability to use UAVs could largely impact survival statistics.

2.3 Community and Other Benefactors

The general public receives benefits from UAV development and use in the form of safety, finances, and benefactors of resource development. These benefits can be direct or indirect to the general public. They receive quick and safe responses from authorities and first responders. UAVs can also be used to inspect utility lines to quickly find any damaged areas. This may not be a matter of safety everywhere, but in Alaska, heat is non-negotiable. Another Alaska specific (or northern specific perhaps) benefit is the ability to map ice-breaking routes using UAVs. Many villages rely on the ability to travel across the ice, or to be able to get ships through ice to receive supplies. UAVs are able to take aerial images and use sensors to determine the best route. This means someone from the community would not be risking their life by going out on the ice and essentially poking around and using their body weight to see what route is possible. This also helps prevent ecological disasters. If the ice were to cut a ship, the oil from that ship would contaminate a lot of resources that these villages rely on.

Besides safety, the general public receives, or could receive, financial benefits from the use of UAVs. If delivery systems such as the much-publicized 'Amazon drone' could be legalized, then delivery and shipping costs could be reduced. Companies would be able to pass the savings on to the public. They also receive financial benefits in the form of resource development.

UAVs are still in their infancy of development, and many jobs will need to be generated to fully integrate UAVs into our lives. With the unlimited possibilities and uses for UAVs, economic development will follow. Engineering, reproduction, and implementation of a whole new blooming industry will cause a ripple effect of benefits to a multitude of people. UAVs could also be used to promote tourism. In Fairbanks this could be very beneficial to the entire community. Tourism is a major income source for Alaska, and UAVs can be used to promote and support tourism in the area. Other mentioned entities that benefit from work with UAVs include the government (state and federal), educators, students, land and homeowners, and other companies in similar fields.

RQ4 (*Is there a difference in attitudes between the two groups?*)

The most negative statements towards UAVs were evaluated between the two groups in the Likert portion of the survey. The lower the mean score, the more favorable the attitude towards UAVs. The higher the mean, the more negative the attitude towards UAVs. Group 1 had a mean score of 1.77 while Group 2 had a mean score of 2.8. This means that the gap in attitude is at least 1 full point out of 5, resulting in much more favorable attitudes with the experts than with the general public. A similar comparison was completed between the two groups regarding their attitudes toward the uses of UAVs. In this comparison, the lower the mean score the more negative the attitude towards UAV implications. The higher the mean score, the more favorable an attitude towards UAV uses. Group 1 had a mean score of 4.7 while Group 2 had a mean score of just under 3.7. Again, the groups are separated by approximately 1 point. This means that experts believe UAVs should be allowed to be used for more tasks, areas, and uses than the general public believes they should be allowed to partake in. However, of the uses named for UAVs, both groups agreed that using UAVs for journalism purposes as the least favorable.

RQ5 (*Is there a relationship between knowledge of UAVs and attitudes towards UAVs?*)

Based on the comparison of knowledge base and attitudes of Group 1 and Group 2, it would appear that a higher amount of knowledge on UAVs does correlate with having a more positive attitude towards them. To further research into this question, the top ranking and the low ranking scores in Group 2 were compared to see if there was a difference in attitudes between them. Again the attitude questions from the Likert scale were taken and averaged between the two scoring brackets. The higher the attitude score, the less favorable the attitude. The lower the attitude score, the more favorable the attitude. The participants in Group 2 that had the highest knowledge score were found to be 24% more favorable towards UAVs than the group that scored lowest on the knowledge test. Although, admittedly, this was not as large of a gap as was predicted, it does still show that there is a relationship between knowledge and attitude.

Significance

This research was conducted with the purpose of providing alternative ways to assist in crisis management planning and execution. To begin that process, a higher level of acceptance and an increased attitude towards using UAVs professionally needs to increase. This information will be useful for search and rescue teams, firefighting crews (both wildfire and structural fire applications), mining crews (for safety exercises and for mine collapse, fires, or toxic spills and leaks) and post-natural disaster rescue teams long term. In the meantime, educational outreach programs and public relation plans need to be established. Use of UAVs in these fields will reduce rescue time and remove humans from the most dangerous positions associated with crisis management situations.

This research can be the starting point for constructing educational outreaches to the general public and also to help develop an inclusive UAV curriculum. UAVs have the potential to be introduced to multiple areas of study, not just the STEM (Science, Technology, Engineering, and Math) studies. For example, UAVs could be used to teach place-based education curriculum in the form of art classes. The UAV would be able to take aerial images of the students' place of study and then the students could draw or paint these images. This would also prompt discussion about local flora and fauna, the presents of people within the environment, and how to avoid damaging the environment, or even ideas on how to restore the area.

This research also contributes to the communication profession by explaining the 'human factor' and its relevance in UAV use as well as the communication 'circle' or process within UAV crews. The human factor includes any perspective, visual response time, and interpretation components associated with UAV response. Research findings also contribute to communication between ground (home base) control and UAVs. The research will focus on ground group response timing with the purpose of providing swift assistance in crisis situations. This can help coordinate communication between the group on the ground and the UAVs to ultimately reduce response time to prevent loss of life.

This study also supports communication theorist Everett Rogers' Diffusion of Innovations model. This theory explains how, why, and when any particular new product, especially technology, is adopted. The main element in diffusing a product include innovation, communication channels, time, and the social system. UAVs are considered the innovation in this situation. They can be called an innovation because they are relatively new and they are still being studied. In order for any product to be widely accepted, communication must take place. The channels of communication for UAV technology thus far have generally been government or research organizations. Media and hobbyist forums are another platform of communication that could be attributing to the lack of knowledge about professional UAVs used for emergency management purposes. An increase in the public's awareness of the benefits of UAVs would be generated from a new channel of communication. This communication channel could be more coverage by the media or by education attempts. In order for any product to be adopted by the majority, passage of time must be allowed. This could be important to private organizations and the public when accepting UAVs. Time will allow for operation and technology improvements to be made by researchers, costs of UAVs to decrease, and an opportunity for the mentioned communication channels to disperse. The most prevalent leaders in the social system in this scenario consists of media, research institutions, and the government. The social system has a large role to play when influencing potential adopters. Lack of adequate positive attention by these leaders can also lead to slow acceptance or product failure. Attempts at increasing public relations (including education fairs aimed at the public) should be put into practice. Improving these four elements of diffusion in regards to UAVs would help increase the likelihood of adoption, and could also accelerate the process (Rogers & Shoemaker, 1971).

Limitations and Future Research

Some possible limitations with collecting data include using online surveys to inventory knowledge with the possibility for participants to search for the answer online as they take the survey. Another possible downfall includes the fact that group 2 participants are not educationally diverse like the general public would be. A positive element about using this sub-section of the population is that it can be inferred that if those who are considered educated were scoring low on the test that it would be safe to conclude that the uneducated portion of the population would see similar or lower results. Additional studies with more diverse 'general public' sample populations should be conducted in the future. Also, it is important to note that the study had a slight bias towards positive responses (with 21 answers that were true and 13 answers that were false).

It is believed that this study has scratched the surface regarding public attitudes, but more could be collected by conducting interviews with those in the general public in addition to the survey. The possible fear or apprehensions of UAVs could be explored and better captured with interviews as well as the attitude inventory. Also, these interviews should include questions about UAVs in the media, and where they have encountered these stories and what impressions it left on them. This will help support the media content analysis. In addition, a similar study focusing on the intentional events (such as terrorist attacks, workplace violence, or public shootings) should be completed as a part of future research.

Another current limitation for integrating UAVs is the general public's fear of UAVs or negative attitudes towards UAVs. This, in part, may be due to media reporting UAVs as dangerous and a threat to privacy. Clear rules need to be established for UAV use and for UAV users. In areas where clear rules have already been established there should be an effort to educate the public about these guidelines and rules. There should also be an effort to explain to the public the differences between recreational or "hobby" UAVs and pilots, and professional or "work" UAVs and pilots. An analysis of media materials should be conducted to identify how many positive versus negative stories involving UAVs are portrayed. Also, this analysis should take note of the use of the word 'drone' versus 'UAV' because it has been revealed in this study that the term drone has a negative connotation while UAV has a more positive connotation.

Also, since it has been shown that lack of knowledge is associated with a negative attitude towards UAVs, an attempt to educate the general public is necessary. After brainstorming with members from Group 1, it is recommended that these educational programs be split into different population segments and should be more customized that previous attempts. It is also recommended that these educational outreaches be very interactive and involved for a deeper level of understanding. In order to improve UAVs integration, the support from the public will be necessary. So, what do the experts want the general public to know about their work and UAVs?

- "A lot of what we do helps the public and we're not spying on them"
- "99% of the drone usage will be to the positive, to the good. There will always be the wrong element that will use technology"
- "The general public needs to know that it's a tool. It's honestly how you use that tool. Much like a gun's just a tool where it's got pros and cons, but that's really no different from a screwdriver-it's a tool, it can be used for good and bad also. To me, I hope the general public understands that it's a tool and it's how it's used and what it's used for.
- "There's no such thing as an unmanned aircraft-there's always a person behind it. Sometimes more than one."
- "They're safe. They can provide access to information that wouldn't be readily available with other capabilities and with the correct use they can provide a safer environment for them to live in."

Conclusion

The overall purpose of this research was to set a foundation for making UAVs in emergency management more accepted and accessible. In order for this to be possible, it is necessary to understand why this is not already the case. This research illuminates some possible barriers such as lack of public knowledge, the public's overall negative attitude towards UAVs, and the relationship between the two. This partnered with the Diffusion of Innovations theory explains a few barriers and reasons why UAVs are not farther along in the emergency management industry. On the other hand, it is also shown that those more involved with public safety and professionals that handle UAVs regularly, have more knowledge of and high attitudes towards UAVs. Identifying the barriers is an important step to achieve success in making UAVs more accepted in the emergency management field. In addition to identifying the barriers, this research recommends additional research, educational outreach programs, and public relations strategies be emplaced.

It is of importance for the general public to accept the integration of UAVs especially in emergency management fields due to the listed benefits that will be received. Not only is this important for personal safety, but the financial benefits would also be beneficial. The general public is so crucial to acceptability that it really is necessary to improve their attitudes towards UAVs. They are important due to the social structure factor in technology acceptance, and also because it is their tax dollars that would partially be funding this integration. Just as business investors need to be on board with funding a new project, the public will need to be on board to fund this section in public service sectors.

Furthermore, the element of educating the general public in regards to UAV uses, potential uses, and laws has been interspersed within this research and recommendations. There are some open house style promotions towards to public currently, but unfortunately proper advertisement and wide spread knowledge of these activities are not in place. The activities already in place meant to teach the public should be advertised more rigorously. Also, these current activities are not targeted towards specific demographics. Specifically, targeted markets should be separated by characteristics such as age, usage, interests, and concerns. It is also urged that professionals in the public safety sectors take responsibility to promote technology integration.

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Appendix A

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Institutional Review Board

909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

February 16, 2016

To:	Amy May, PhD Principal Investigator
From:	University of Alaska Fairbanks IRB
Re:	[870234-1] Unmanned Aerial Vehicles: A Crisis Communications Application

Thank you for submitting the New Project referenced below. The submission was handled by Exempt Review. The Office of Research Integrity has determined that the proposed research qualifies for exemption from the requirements of 45 CFR 46. This exemption does not waive the researchers' responsibility to adhere to basic ethical principles for the responsible conduct of research and discipline specific professional standards.

Title:	Unmanned Aerial Vehicles: A Crisis Communications Application
Received:	February 12, 2016
Exemption Category:	2
Effective Date:	February 16, 2016

This action is included on the March 2, 2016 IRB Agenda.

Prior to making substantive changes to the scope of research, research tools, or personnel involved on the project, please contact the Office of Research Integrity to determine whether or not additional review is required. Additional review is not required for small editorial changes to improve the clarity or readability of the research tools or other documents.

Appendix B

Interview Questions

Professional Experience

What is your job title/role

When have you used a UAV during your role as ____________ (insert answered job title given)

What current projects do you have using UAVs?

What has your experience with UAVs been?

How was the UAV used?

How did the UAV aid?

Limitations

What limitations does the UAV that you generally use have?

What do you wish it could help you do more of?

Do you have financial limitations within your company that does not allow for additional UAVs/UAVs of higher technology or UAV training?

Public Involvement

Has the public been impacted/involved/received any benefits of your work with UAVs?

Do you think the general public in the Fairbanks/North Star Borough understand what UAVs can be used for?

Do you think the general public has a favorable or unfavorable attitude towards UAV use? Why?

Do you think it would be beneficial to do an educational outreach to the general public?

What is the one thing you want the public to know about UAV potential/how they are used?

Appendix C

Survey Questions

Part A: Qualifying Information

Qualifying Question

1. Do you live in the Fairbanks or North Star Borough area? (Yes or No)

Part B: Knowledge Inventory

Identifying UAVs

1. Do you know what a UAV is?

☐ Yes ☐ No

2. What does UAV stand for?

---

3. What is a drone?

---

4. Are drones and UAVs the same thing?

☐ Yes ☐ No

Additional comments:

---

5. Identify the drone/UAV that you are most familiar with

☐ ☐

Knowledge of Uses of UAVs

UAVs are currently used for: (T or F)

1. Military air strikes

2. Recreational enjoyment

3. Wildlife counting and monitoring

4. Oil-field infrastructure inspection

5. Search and rescue missions

6. Mine accident rescues

7. Corporate deliveries

8. Police assistance

9. Firefighting assistance

10. Journalism purposes

11. Postal service assistance

12. Private investigations

13. Increased personal viewing of sporting events

14. Personal civilian GPS tracking of people or possessions

15. Space exploration assistance

<u>Knowledge of laws on UAVs</u>

1. There are laws about UAVs (T or F)

2. There is an organization that regulates UAVs (T or F)

3. Which organization regulates UAVs? (select one)

a. The FAA ------------------ ☐

b. The ICC ------------------ ☐

c. The FDA------------------ ☐

d. The TRAI------------------ ☐

4. What does the FAA stand for?

---

5. The current regulations/laws for UAVs are: (True or False)

a. There are three categories of UAVs that the FAA recognizes (public, civil, and model)

---

b. For public aircraft operations, a Certificate of Authorization (COA) must be obtained

---

c. To be able to fly a civil UAV you can obtain a Special Airworthiness Certificate (SAC)

---

d. To receive a Special Airworthiness Certificate (SAC) the applicant must be able to describe how their UAV is designed, constructed, manufactured including engineering processes and software development

---

e. To fly recreationally you must fly below 400 feet

---

f. To fly recreationally you must keep the UAV in your direct line of sight

---

g. To fly recreationally you may not fly within 5 miles of an airport

---

h. To fly recreationally you must stay away from people

---

i. to fly recreationally your UAV must be under 55 pounds

---

j. The FAA can fine you for not adhering to the laws about UAVs

k. The FAA sponsors a program for educating recreational flyers called *Flying Responsibly*

l. Police need a warrant to observe you with a drone flying below 400 feet.

m. Police flying a drone to the scene of a crime can only use footage acquired at the crime scene itself.

n. Most "drones" used by the U.S. military overseas are armed.

o. The FAA predicts as many as 30,000 drones by 2030.

p. The Supreme Court's January 2012 decision in Jones (the warrantless GPS tracking case) means that police need a warrant to follow your car using a drone.

q. You can shoot down a drone if it is flying over your private property

Part C: Personal Involvement with UAVs (Yes or No)

1. I own a UAV for recreational/hobbyist purposes

2. I have flown a UAV before for recreational/hobbyist purposes

3. I have been around a friend or family member while they flew a UAV for recreational/hobbyist purposes

   If yes, explain:

4. I have had some other experience with recreational/hobbyist UAVs

   If yes, explain:

5. I have flown a UAV for work purposes

6. I have been around a fellow employee while they flew a UAV for work experiences

   If yes, explain

7. I have had some other experience with UAVs for work related purposes:

   If yes, explain

8. I currently work in, have previously worked in, or have association with one of the below areas (click all that apply)

-Military (any branch) ------------------ ☐

-Civilian contractor for the military or government------------------ ☐

-Wildlands firefighting------------------ ☐

-Structural firefighting------------------ ☐

-Police force (including dispatch) ------------------ ☐

-Mining------------------ ☐

-Wildlife counting and monitoring------------------ ☐

-Search and rescue------------------ ☐

-Crisis management ------------------ ☐

(If answered yes to an of the above careers)

1. Did you use UAVs during your employment/association with the above fields?

(if yes) Explain:

---

2. I have heard about/seen UAVs from a news or media source? (online, news, TV, etc.)

If yes, explain

Part D: Attitude Inventory

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

Number	Question	Answer
1	I believe I am well informed about UAVs	
2	I believe I am well informed about laws and regulations pertaining to UAVs	
3	I have personal interest in UAVs	
4	I believe UAVs should be illegal	
5	I believe we should be able to use UAVs for military air strikes	
6	I believe we should be able to use UAVs for search and rescue purposes	
7	I believe we should be able to use UAVs for police assistance	
8	I believe we should be able to use UAVs for firefighting purposes	
9	I believe we should be able to use UAVs for wildlife monitoring purposes	
10	I believe journalists should be able to use UAVs for news related stories/segments	
11	I believe we should be able to use UAVs for recreational/hobbyist enjoyment	
12	I believe we should be able to use UAVs for border patrol purposes	
13	I believe the laws of UAV use are strong enough	
14	I believe the government uses UAVs to spy on citizens	
15	I believe UAVs are a public nuisance	
16	I believe UAVs are dangerous	
17	I believe UAVs are a threat to safety	
18	I believe UAVs are a threat to privacy	
19	I believe anyone should be allowed to buy and operate UAVs	
20	I believe UAVs are more dangerous than they are beneficial	

Part E: Demographics

1. What is your highest level of education?

-No schooling completed------------------ ☐

-Nursery school to 8th grade------------------ ☐

-Some high school, no diploma------------------ ☐

-High School graduate, diploma or equivalent (for example: GED) ------------------ ☐

-Some college credit, no degree------------------ ☐

-Trade/technical/vocational training ------------------ ☐

-Associates degree------------------ ☐

-Bachelor's degree------------------ ☐

-Master's degree------------------ ☐

-Doctorate degree------------------ ☐

2. What is your Gender identification?

-Male------------------ ☐

-Male to female transgender------------------ ☐

-Female------------------ ☐

-Female to male transgender------------------ ☐

-Androgynous------------------ ☐

-Not sure------------------ ☐

3. What is your age?

-18-25------------------ ☐

-25-30------------------ ☐

-30-35------------------ ☐

-35-40------------------ ☐

-40-45------------------ ☐

-45-50------------------ ☐

-51+------------------ ☐

4. What is your political affiliation?

-Apolitical------------------ ☐

-Democrat------------------ ☐

-Republican------------------ ☐

-Libertarian------------------ ☐

-Independent------------------ ☐

-Not sure------------------ ☐

-Other ------------------ ☐

5. What is your ethnicity?

-White------------------ ☐

-Hispanic or Latino------------------ ☐

-Black or African American------------------ ☐

-Native American/American Indian/Alaska Native------------------ ☐

-Asian or Pacific Islander------------------ ☐

-Other------------------ ☐

6. Employment status: Are you currently...

-Employed for wages------------------ ☐

-Self-employed------------------ ☐

-Out of work but looking for work------------------ ☐

-Out of work but not currently looking for work------------------ ☐

-A homemaker------------------ ☐

-A student------------------ ☐

-Military------------------ ☐

-Retired------------------ ☐

-Unable to work------------------ ☐

Part F: Follow-up

1. Would you be available/willing to provide this study with follow up information in the form of an interview? (yes or no)

-if no, takes them to the end of the study that says 'thank you for your participation in this study'
-if yes, contact information (email address) will be collected for possible follow-up.