

Improved Productivity, Efficiency and Cost Savings Following Implementation of Drone Technology in the Surveying Industry

Joseph Fassbender, Amey Balasaheb Sanap, Kimya Green and Jeong-Han Woo Ph.D.

Department of Construction Management, Architectural Engineering and Civil Engineering, Milwaukee School of Engineering University, United State of America

Email: fassbenderj@msoe.edu, sanapa@msoe.edu, greenkd@msoe.edu, woo@msoe.edu.

Abstract

The goal of this study was to identify any potential benefits drone technology offers in the surveying industry as compared to traditional methods. Drone technology has advanced rapidly over the past decade, offering greater capabilities every year. These technological advances were the inspiration for this research, with an ultimate desire to identify current survey process improvements. The research was carried out in an interview format with professionals from companies offering services within this industry. It was found that replacing traditional surveying methods with drone technology results in overall cost savings for the company and increased efficiency by their field crews. These findings provide significant data for companies with surveying service offerings as operating expense reduction and efficiency increases are realized following the implementation of this new technology.

Keywords –

Drone; Unmanned Aerial Vehicle; UAV; Surveying; Construction

1. Introduction

Arguably, one of the most important factors determining the result of a construction project is site and building surveying. The surveying & mapping industry had a value of \$6.672 billion in revenue in 2016. This market peaked in 2007 at \$8.173 billion and fell hard following the financial crisis. With the construction industry on an upward trend again, the surveying and mapping industry has followed suit [6].

Profitability, accuracy and efficiency are critical aspects to the overall quality of the construction project, requiring that the project be complete per the construction documents and that the initial land surveys were exact. This is regularly done and tracked with surveying equipment to ensure project components are in

agreement with where the project is proposed to end up. Traditional surveying not only requires that expensive instruments be used and maintained, it can also be a relatively slow process.

Current human surveying crews are required to perform numerous equipment set-ups in order to achieve total visibility of a site. Often, many obstructions come into play on active construction sites, which in turn require even more station arrangements for the crews. For each station set-up the crew is required to do, productivity drops and costs quickly escalate due to this lost time. If a crew is not physically surveying or mapping, that time spent setting up or reviewing data can be viewed as lost time. Each new set-up requires the equipment to be moved, re-leveled, and back-sights must be shot.

Enter the use of drones; what was initially a military tool, advancing to a toy for people to enjoy has now become a critical tool for the construction project process. Drones were introduced to the construction industry as a means to photograph projects through construction and at completion. They provided project teams an opportunity to access a “bird’s eye” view of their construction site at a rather minimal cost. Through the advancement of technology, however, developers have found a way to utilize drones to analyze what they are seeing and provide a report to the team. The many new uses will continue to grow as drones become more common and the governing rules ideally continue to adapt and loosen.

The new, highly advanced drones available on the market today offer technology that can take the place of former surveying crews and be operated by a single individual. Partnered with a tablet and application, the drone can provide real-time surveys of the geography or structures being assessed. Not only this, operators can also program a route for the drone to take, ultimately mapping the survey process before it even begins [7].

This research investigated if drones provide both a cost and time savings for companies in comparison to traditional surveying crews. New technology

Improved Productivity, Efficiencies and Cost Savings Following Implementation of Drone Technology in the Surveying Industry

theoretically should lead to increased productivity, efficiency and reduced costs to surveying companies. Potential roadblocks were also researched to determine what might currently be decisive factors pushing surveying companies away from the new technology. Some publications have been accessed to provide further sustenance to this research.

Additionally, the biggest cost savings we suspect/anticipate was in the form of reduced labor hours. Surveying companies should be able to cover more sites, meaning increased productivity. This might allow them to reduce their number of crews since they can now cover more ground with fewer people, ultimately reducing their expenses on equipment. In addition, drones typically only require a single operator, while survey crews typically are comprised of two people, although a surveyor could work alone if needed.

2. Literature Review

The construction industry has unfortunately gotten a reputation of being sluggish, plagued with inefficiencies and ultimately resistant to change – mostly because those that make up the industry are technology adverse and believe that doing things the way that they've always done them is perfectly sufficient. This is not a new trend but one that has seen decades come and go. Technology, however, has refused to accept this fact and has made data collection, organization and sharing impossibly easy; so easy that it would be self-destruction for a modern firm to not take advantage of profit margin protecting efforts that are now available.

Because our research has highlighted the many uses, advancements in time savings to the planned schedule, improved material, safety and job-site monitoring and continual ingenuity and innovation for the use of Unmanned Aerial Vehicle (UAV) technology, we have found it imperative to research and discuss some of the many ways industry has decided to implement UAV use and improve their business.

There were many examples of the bird's-eye view and with "Job Site Monitoring: There is huge potential here. As it stands, flying a UAV over people is not allowed without a permit, but the Federal Aviation Administration (FAA) works with applicants who are willing to prove their processes are safe (and who have proper liability insurance)" [2]. This may be one of the largest issues currently facing drone implementation in surveying. The FAA has some restrictions governing who can use drones, for which purposes, when they can be used and why the use is necessary for their business. If companies are required to go through too intensive of a permitting process for each site they intend to survey, it is safe to assume many companies will remain with traditional technologies and processes already discovered

and controlled. Additionally, there are other risks and costs associated with making sure that the proper liability insurance is maintained and covers all of the evolving hazards and threats that continue to develop on the surveyed site/location.

While traditional methods may be slightly more time consuming in the field and require data compilation following the survey, this might still be a better option than using drones if flight restrictions remain at the current level. It would take additional full-time staff to continually work through the permitting process for each site requiring clearance. It will be interesting to see where time takes this particular issue and if organizations will deem it valuable to invest this level of attention from their firm and the potential profit realized for the given project.

"According to a March 2016 report from Goldman Sachs, construction will be the largest use case for commercial drones in the immediate future, generating \$11.2 billion of the projected \$100 billion in global spending over the next five years" [3]. This is an exciting fact for our research. Over 10% of commercial drone spending in the next five years will be focused directly on construction. This indicates a growing demand for the services and shows a bright outlook for the technology.

Companies clearly see an advantage to using the new technology; it can only be expected to get better as technology advances continue to surface. UAV training entities and software leaders continue to evolve and present products to an industry that has resisted this type of change for so long. We believe that the numerous software products used by various stakeholders to realize simple collaboration within a project will become an issue of focus that competing software organizations will seek to find appropriate (streamlined) solutions for and that eventually an answer will inevitably emerge. We also believe that consistent FAA standards and subsequent workforce training will eventually saturate the industry to further stabilize the technology and encourage complete business adoption.

"Drone technology is moving extremely fast. It's very possible many surveyors would rather hire a service provider to collect data than invest in a tool that can be obsolete in as little as six months. They may also consider short-term leases to ensure their technology is relatively current or just rent a drone when needed" [5]. The continuous advancements in drone technologies and their uses deter many companies from potentially purchasing new drones as they would rather have subcontractors or other firms collect the data or simply wait until the drone market steadies more. There are fears that drones are merely a phase in surveying technology evolutions and some companies may not feel comfortable investing such large capital resources in technology that could possibly

Improved Productivity, Efficiencies and Cost Savings Following Implementation of Drone Technology in the Surveying Industry

soon be out of date and not produce the anticipated or desired return on investment (ROI).

“They are finding a much higher return on investment due to more accurate data being accumulated by fewer people in less time with quicker results. Not working with a modern surveyor employing the best techniques is far too expensive a proposition for many companies, and they are finding the change worthwhile” [4]. Drones help in collecting accurate data relatively inexpensively. There seems to be an upward trend in organizations attempting to use drone technology because companies that have switched to the technology are able to provide accurate data that is collected by fewer people and in noticeably less time.

“The number of surveyors is actually projected to decline by two percent from 2014 to 2024 because of improved surveying technology” [5]. Thanks to advances in surveying technology, the physical number of surveyors is projected to decrease by two percent. According to the US Department of Labor, there were 44,300 surveyors in the United States in 2015. With these projections, as the industry continues to grow, the number of employees will actually drop by nearly 9,000 positions. While this is an unfortunate outlook for the job market, this projection provides a bright outlook to the industry regarding advances in technology drones can bring to the surveying industry.

3. Research Methodology

Our research included a combination of scholarly and trusted online article sources and one-on-one interviews conducted directly by our group. In most cases, we were able to speak directly with the manager of the department that operates the drones or with the individual who utilizes the drone in their daily tasks. In other instances, we emailed these same stakeholders; the same ten (10) questions were used in both scenarios. We’ve attempted to resolve with our research these two fundamental questions:

1. Have drones provided surveying companies with cost savings over their traditional surveying efforts?
2. Has the use of drones in surveying provided increased efficiency and productivity for their organizations?

3.1. Expert Interviews

In order to provide high quality responses to the aforementioned research questions, the group undertook a research method geared towards interviews. Approximately twenty-five (25) organizations were initially identified to interview. These companies were believed to have utilized human work crews at some time to capture surveying data and information and have since switched over to some degree to the use of drone

technology. Of the twenty-five (25) companies chosen, we received feedback from seven (7) of those groups. The eighteen (18) that did not participate had varying reasons for not providing feedback. The large majority felt some of the information being requested was proprietary and preferred not to answer. The others either did not respond promptly within our research timeframe or they did not respond at all. Upon contacting the companies, the team conducted an interview with the following questions:

1. When did your company begin to incorporate drones in surveying procedures?
2. What kind of drones are you using?
3. What is the average upfront cost of the new technology per drone the physical drone and any necessary software?
4. Have you noticed a cost savings after switching to drones?
5. What was the deciding factor to switch to this surveying technology?
6. Have you noticed an increase or decrease in productivity with the new technology?
7. Approximate percentage of increase/decrease?
8. Do you have any reservations in using drones versus traditional human survey crews? Are you concerned about data quality?
9. Are there any legal or logistic hurdles that need to be overcome?
10. Are there any additional services your company has begun offering with the addition of this new technology?

The questions were not strictly seeking numerical responses, which makes visual comparison difficult through diagrams and charts. Often, the interviews were largely conversation based with in-depth dialogue regarding each question to better understand the industry. While we made efforts at extracting hard numbers from the responses, the majority of our data is dialogue from those conversations. With the responses from these interview questions, we have reviewed the data to identify trends. These trends will be used to answer the research questions, and will ultimately lead the team to providing a final decision on the thesis. In addition, the team will look into potential risks associated with drones, the evolving legal and regulatory compliance linked with their use, and the conceivable advancements this technology is sure to bring.

3.2. Research from One-on-One Interviews

Within our research we found that the organizations that we received responses from all in fact used a traditional (human/manned crew) form of surveying prior to their implementation of UAV equipment. There was

Improved Productivity, Efficiencies and Cost Savings Following Implementation of Drone Technology in the Surveying Industry

one relatively early adapter who began their use in 2011. However, the other six respondents stated that they began to use drones in 2015 or 2016, four companies and two companies respectively. Likewise, most organizations made a significant upfront financial investment for the drone itself and the associated software packages; in some cases, this also included any initial training as well.

The average cost per drone varied greatly from company to company, however, it appears that companies typically spend between \$40,000-\$60,000 per drone including any software. Those drones that are being purchased and used also proved to be anything but standard; we found that the following drones are being used: the DJI Phantom 4 Pro, Trimble UX5, Skycatch, Firefly VTOL, Matrice 100/600 series, 3DR Solo, Sensefly eBee, Inspire 1v2, Pulse Aerospace Vapor 55, Albris and even some custom-made drones. The lack of “industry standard” when it comes to drones made comparing apples to apples difficult in regards to the cost of the upgrade. The number of drones needed, the capabilities of those drones, and the financial resources available among other factors seemed to cause a wide variation in the upfront capital expenditures by the companies interviewed. A larger sample size with more refined financial questions would further narrow in on costs associated with this technology upgrade. Nonetheless, valuable data was gathered from the seven respondents, which effectively illustrates that there is no standard practice currently in place within the surveying industry.

The amounts spent on these technologies, we have discovered, also depends on the type of surveying products that will ultimately be produced. In our research efforts, we found a nice sampling of organizations that produce small to large scale surveying projects. The

higher the initial upfront costs, the larger the scale of surveys performed and vice versa. For instance, “Co. 2” spent approximately \$300,000 for their UAV equipment and classifies their expenditure along military-grade alignment. “Co. 2” uses their drones to cover several miles, similarly to manned helicopters that were previously used for surveying projects that cover hundreds of acres. Other organizations have varying levels in scale of this and their initial expense also reflect the measure of surveying projects that they perform. Some organizations perform more of the marketing, or monitoring, type of project and the UAV’s that are able to fly and hover lower to the ground are more useful for their requirements. Still others have been used to perform the more traditional construction surveying projects of parking lots, pre-construction and construction monitoring and 3D & 4D imaging – and these constitute the more average, mid-range expenditure.

One of the desired research outcomes was to determine if drones provided companies a savings in time and money. According to the interviews conducted, every company said the use of drones has reduced costs on many, if not all projects. In addition, many companies saw an increase in productivity at least by 50% through the implementation of drones; mostly these increases in productivity are exemplified by their ability to take on more work with the same human workforce. One interviewee stated this productivity increase is thanks in large part to improved workflows and overall efficiency with the surveying being done from above, rather than on the ground.

Most of the companies interviewed stated that one of the primary deciding factors to incorporate drones in their company’s operations was due to the anticipated cost savings. It appears that each company had done rather extensive research prior to taking this step forward in technology. Other recurring factors that pushed companies toward the technological upgrade included increased efficiency, enhanced safety for those manned work groups on the ground, improved precision and detail, while still others knew that the industry was progressing to this technology and was dedicated to take advantage of the advancements it offered.

The other desired research outcome previously identified by our group, was to ascertain potential legal or logistical issues that are present with drones that were not previously considered. The largest legal matter mentioned by companies was flying restrictions. It takes logistical planning with the Federal Aviation Administration (FAA) for airspace planning prior to the act of surveying. Although the FAA regulates airspace usage and logistics, one company interviewed by the group felt that those regulations were not enough for this new niche within the surveying industry. The person interviewed identified that there is “a growing concern

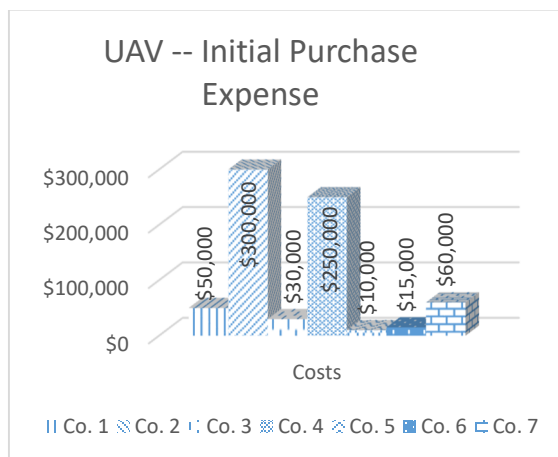


Figure 1. Graph depicting the initial costs associated with acquiring the equipment to begin surveying using drone technology.

Improved Productivity, Efficiencies and Cost Savings Following Implementation of Drone Technology in the Surveying Industry

that unskilled people are using the technology without grasping the complete knowledge of what needs to be done to produce quality work. As this happens, it will push back the industry and build a rift with the public against the new technology. There should be regulations and a licensing board [established].” It appears, according to these comments, that drones with surveying capabilities are too accessible to the general public that could allow anyone to buy one, advertise as a “surveyor” and perform poor quality work. This would be significantly detrimental to the industry, driving a wedge between the new technology and potential clients.

Drones do have identified risks associated with their use and organizations have decided to use the art of collaboration to minimize their exposure. Some of the alliances include partnering with entities that have specific drone insurance to help absorb some of the risks or with firms that employ individuals with aviation knowledge and experience (licensed pilots). In other examples, collaborators may also use UAV equipment that is different from what the original organization may own, which ultimately improves their capacity and the product deliverable and quality; while the other gains access to additional markets.

At this time, companies did not appear to have any reservations in utilizing UAV/drone technology. Some of these entities expressed skepticism that sat in the back of their minds surrounding the new technology, however each company seemed to have their own set of checks to ensure accuracy was of the highest quality and improved the overall industry, trade and public perception.

The final finding from the interviews showed that there are two companies that have not added additional services to their product offerings after supplementing their fleet of equipment with drone technology. While still the majority of companies interviewed have taken on different types of projects from their original surveying work. Some of the new contributions included buried pipeline mapping using thermal sensors, before & after work pile photography and wildlife conservation type projects. Others have found that inspection photos and thermal imaging are great ancillary products to be offered in tandem with their main services; however, they have focused on offering their services to new industries that have not used Light Detection and Radar (LiDAR) technology before. Most have found that having the technology is actually more of an expansion of their market instead of the actual services that they are able to offer.

And still others have decided that the drone itself is considered a “new” service offering from their original organizational structure. They have been able to offer services to “site prep” companies, which basically are tasked with moving large amounts of dirt from the site. One company is now able to monitor the dirt being

removed and mark it or data point it over the period of time, as well as offer a visual image of the site. It is noted that companies tend to like the visual and bird’s eye view and this fact offers a marketing tool opportunity or communicable image of what a company actually performs.

Finally, those entities that have offered an altered service mix note that they are better able to understand a number of technologies due to the drone. It’s possible, not as a direct result, drone technology has inspired all within the company to be more creative and dynamic. This is because of the seemingly ever-expanding nature of the drone concept. These companies are currently pursuing sales in the Thermal, Multi and Hyperspectral, LiDAR and Normalized Difference Vegetation Index (NDVI) markets using drones.

For those who did not alter their product mix, this came as a bit of a surprise to the group as we anticipated seeing some service expansion or minimally some alteration. It does appear, however, that the addition of drones has provided both cost and time savings to all of the companies that are providing surveying services and throughout the interviews, these organizations expressed being pleased with their expenditure and identified noticeable overall improvements.

4. Conclusions

We have discovered that the organizations that we have interviewed, as well as the subsequent research we performed, made one point abundantly clear and that is that introducing drone/UAV technology to their firm has found cost savings and improved project scheduling. As discussed throughout the paper, we have highlighted the labor/crew hours that have readily been absorbed by most firms by increased projects, improved safety and job-site related efficiencies, increased collaboration and potential new product offerings.

Our group has set forth to explain the cost savings organizations have found because of their use of drone and UAV technology versus the more traditional ways to survey sites of varying forms. We planned to explore the potential differences of productivity in surveying using drones versus traditional surveying methods. The biggest cost savings we found emphasized by the interviewed companies were in fact in the form of reduced labor hours; or, it was often times quantified by increased project/job capacity.

We also discovered that because surveying companies were able to cover more sites, they were able to illustrate specifically that productivity increased substantially and warranted the implementation of new products or overall organizational growth.

Again, these forms of increased productivity were demonstrated in some ways by the reduction of crews

since these specific companies were then able to capitalize on more ground with fewer people in the crew, which ultimately reduced their expenses on equipment as well as for other manual surveying procedures and continued training. In addition, drones typically only require a single operator, while survey crews typically are comprised of two or more people, although a surveyor could work alone if needed.

Again, drone and UAV technology present their own list of challenges and business structure necessities. FAA regulations, improved insurance and safety procedures, as well as the continued expense for training in an ever-evolving technology and market/industry are all examples of the new issues to be monitored and controlled by organizations. These potentially, and arguably, are substantially less taxing on a company than the traditional way of conducting surveying projects on the construction site. We believe that our research has exhibited the increased efficiencies and financial savings that have been realized by those innovative companies that invest in the drone technologies.

Resources

- [1] Dillow C. (2016, September). The Construction Industry is in Love with Drones. On-line: <http://fortune.com/2016/09/13/commercial-drone-construction-industry/>, Accessed: 18/09/2017.
- [2] Norris A. (2017, January). How Drones are Helping Construction Companies Make & Save Money. On-line: <https://www.suasnews.com/2017/01/drones-helping-construction-companies-make-save-money/>, Accessed: 18/09/2017.
- [3] Link J. (2016, November). Here Comes the Next Big Technological Boom: Drones in Construction. On-line: <https://www.autodesk.com/redshift/drones-in-construction/>, Accessed: 18/09/2017.
- [4] McCullough D. (N/A). How Surveying with Drones Changes Everything. On-line: <http://www.landpoint.net/how-drones-will-revolutionize-land-surveying-services/>, Accessed: 18/09/2017.
- [5] Snow C. (2016, July). The Truth about Drones in Mapping and Surveying. On-line: <https://www.suasnews.com/2016/07/truth-drones-mapping-surveying/>, Accessed: 18/09/2017.
- [6] Tatum M. and Liu J. A conference paper. In *Unmanned Aerial Vehicles in the Construction Industry*, pages 1-11, Auburn, Alabama, 2017.
- [7] Zullo F., Marucci A., Fiorini., Ciabo S. and Romano B. A conference paper. In *New techniques for land surveying, monitoring, and environmental diagnosis: a comparative analysis*, pages 1-23, Naples, Italy, 2016.
- [8] Turner I., Harley M. and Drummond C. A conference paper. In *UAVs for coastal surveying*, Sydney, Australia, 2016.
- [9] Kameri-Mbote P. and Muriungi M. A journal article. *The African Journal of Information and Communication (AJIC)*, 20:159-169, 2017.