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A Review of Advanced Technological Tools Currently Used in AEC Industries

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ABSTRACT: Information technology for decades has been a great tool for all branches of business professionals since its inception. Beyond manufacturing industries, other professions such as engineers, architects and constructors have gained the most benefits from adopting technological tools. Although, construction industry was among the slowest to adopt computer systems in 80's, the rapid technological advances in information technology have now provided new opportunities and valuable tools for construction. The conventional construction methods are no longer responsive to large structures with many sophistications. In today's world of construction, technology is used for everything that is done on a day to day basis. Since this industry is set to be worth billions in the next few years, it is no surprise that the rise of technology, specifically drones, is taking over. They are being used for land surveys, building inspections, monitoring on-site activities, data mapping, and security surveillance and are extremely helpful with larger structures like skyscrapers. This article focuses on the current applications and tools of information technology in construction in general, and mobile devices and drones in specific.

KEYWORDS: Information Technology, AEC Industry, Building information Modelling, Unmanned Aerial Vehicles, Drones in Construction, Automation in Construction, robots

I. INTRODUCTION

Construction can be very complex and challenging if we don't adapt to change. Technology changes every day it seems like. Once you can get your hands on the latest and greatest iPhone there is newer and better version being released the very next day. Construction isn't any different. Designers and Architects are brainstorming more modern style buildings to put their thumbprint on society and it's our task to figure out how that design is going to become a physical structure. Advancements in technology are making these challenges much easier.

Before any design software was available, Architects would draft their visions using paper and pencil. Although this is seen as a talent and skillset, it often resulted in many complications during construction. Think about it, there was generally only a few sets of the drawings made, due to the lack of printing resources at the time, which made it challenging for contractors to accurately build according to the drawings. When things deviate from the completed drawing sets, it makes for possible change orders that either the Owner or the Contractor would end up having to pay for. Since there were fewer sets of drawings there were fewer people who were able to see and understand the drawings. This also resulted in longer construction durations (17). Today, it is much more streamlined for construction workers to get their hands on a set of drawings. Architects now use computer design software to design buildings and structures at a much faster rate. The beauty of this is that now, using software, drawings can now be saved and sent to multiple contractors at once and to as many as possible. With so many people involved in a construction project having access to the drawings, it helps to ensure that the vision of the designer is brought to life with minimal mistakes. These can all be accessed on mobile devices such as tablets and cell phones.

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II. RELATED WORK

Our methodology is to investigate the current applications of technology and tools used in AEC industry. This requires to study scholarly articles and commercial applications of information technology in this field and evaluate their importance in the business. Following paragraphs provides the related information and applications of these tools.

“Perhaps the most widely adopted of all new technologies are mobile devices. With their easy-to-use apps, they allow workers to access, document, and share and edit important project information even while on the jobsite. Heavy-duty devices made specifically for field work feature rugged construction, screens that are better lit for viewing in bright daylight or poor weather conditions, and industry-specific components such as barcode scanners and radio-frequency identification readers (both of which can help track shipments, equipment and materials) (18)”.

Another technological advancement in construction has been the evolution of drone usage in the construction industry. Drones are very useful, especially in construction. They allow the project team to survey the progress from all angles. “In the last few years, drones have helped make several improvements in construction, from increased accuracy in reporting, to improving safety conditions, to cutting costs and increasing efficiency (12)”. In my experience we have been able to use them to take job wide 360 degree photographs. “With drones making it easier and easier for companies to provide visual data on the progress of a construction project, clients can now get quick updates on how things are proceeding. These updates include detailed maps of the entire site with GPS points, which allow you to zoom in and view small details of the area (12)”. The use of drones allows for contractors to keep Owners and clients in the loop of what is going on. “Photos, videos, 3D models, and orthomosaic maps created with drone data can be used to provide clients with detailed, real-time reports on how things are progressing on-site. On larger construction projects, there are often multiple stakeholders in multiple locations who are all eager to know how things are progressing. Without a drone collecting visual data, clients would have to walk a site in person to see how things are moving along or hire a helicopter at a prohibitively high cost to collect aerial shots or video. And even if they did take this step, the shots collected could be outdated after the next workday (9)”.

In construction, safety concerns are always at a premium. Every day, OSHA is out and about trying to ensure that safety standards are being met in the construction industry. OSHA is the Occupational Safety and Health Administration that sets the standards for safety in the workplace. “Since drones make the collection of visual data so much cheaper, construction companies can use drones in construction work to do aerial surveys more often, and this data can help them stay on top of changing conditions that may impact safety. And safety on a construction site isn’t just about keeping workers safe—it’s also about finding access points where civilians could enter the work area and potentially hurt themselves. Identifying a breach in the perimeter of a site on the same day it happens, instead of the next time someone walks by that specific area on foot, could make all the difference in preventing an accident (12)”.

The construction world continues to evolve as technology does. One of the things that has helped it evolve is the introduction of BIM technology. BIM is building information modeling and it allow for design teams to collaborate with one another to develop the best strategic plan for the erection of a structure. “In the past, blueprints and drawings were used to express information about a particular building plan. This 2D approach made it very difficult to visualize dimensions and requirements. Next came CAD (Computer Aided Design), which helped drafters see the benefit of plans in a digital environment. Later on, CAD turned 3D, which brought more realistic visuals to blueprints. Now, BIM (Building Information Modeling) is the standard— but it’s more than just a 3D model (14).” BIM has shaped the future of construction by revolutionizing the industry. It has set a bar higher than what original blueprints ever did and will continue to advance as time goes on. “Because of the clear benefits, it’s certain that BIM is here to stay. It has defined goals and objectives that are clearly beneficial to all those who work their way through the levels. Undoubtedly, the future of construction will be even more highly collaborative and digital. As BIM becomes increasingly more sophisticated, 4D, 5D, and even 6D BIM will start to play a part in the process. Furthermore, around the globe, there is an attempt to reduce waste in construction. Much of this is attributed to supply chain inefficiencies, clashes, and reworking. By working collaboratively in a BIM environment, all of this becomes much less likely, setting the stage for a better tomorrow (14).”

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Robotics have also been an integral part to the growth of the construction industry. Many of people do not like to hear about robots in the work place because of how they seem to take away jobs from Americans, however, they do have advantageous results in construction. “An example of how construction robotics are revolutionizing the industry can be seen in the HadrianX bricklaying machine from Australia-based FBR Ltd. (also known as Fastbrick Robotics). It employs an intelligent control system — aided by CAD — to calculate the necessary materials and movements for bricklaying (13).” “While Hadrian does require the use of proprietary blocks and adhesive, FBR noted that the related materials are “12 times bigger than standard house bricks” and are lighter, stronger, and more environmentally sustainable. Robots like Hadrian and SAM100 from Victor, N.Y.-based Construction Robotics promise to reduce operating costs and waste, as well as provide safer work environments and improve productivity. Hadrian can build the walls of a house in a single day, which is much faster than conventional methods (13).”

Robotic equipment provide an advantage because the equipment does not require any operators. “While the major automakers and technology companies are working on self-driving cars, autonomous vehicles are already part of construction robotics. Such equipment can transport supplies and materials. For instance, Volvo has been working on its HX2, an autonomous and electric load carrier that can move heavy loads without additional input. It has no driver cab and instead uses a digital logistics-driven control technology backed by what Volvo calls a “vision system” to detect humans and obstacles while on the move (13).”

III. DISCUSSION

In March 2018, Rachel Burger (7), a Senior Project Management Analyst and Content Writer, wrote an article that was published on thebalancesmb.com titled *6 Ways Drones are Affecting the Construction Industry*. She talks about how construction companies can, in a way, avoid these regulations. Most construction companies use drones under the 4.4-pound weight limit and fly in a 400-foot travel radius. Because of this, the drones they are flying are considered “hobby class,” meaning they are small enough and do not need to follow the strict criteria the government declares.

In her article, Rachel Burger states, “The presence of drones in construction means significant changes within the industry. Drones have already begun changing the way the construction industry operates, and those changes will have continued and lasting effects”. We have consolidated her *6 Ways Drones are Affecting the Construction Industry* into four categories: Surveying Land, Communication, Transportation, and Security and Surveillance.

Surveying Land

Drones are replacing traditional land surveillance methods because they are getting more and more popular. The expression “bird’s eye view” is abandoned for the more appropriate expression “drone’s eye view.” Drones are the preferred surveying method because they are cheaper, faster, and more accurate as they eliminate most of the human error involved in the process compared to traditional methods. They are also extremely useful in surveying dangerous locations, reducing risk of injury, and increasing employee safety.

Communication

Communication when doing anything is extremely important, especially when at a construction site. Drones are useful as a means of maintaining constant contact at worksites. Drones with cameras capture video footage, which allows contractors to keep eyes on employees and the project’s progress. This is very useful to superintendents and investors. Communication is already at a peak with the technology we have in smart phones, but with the addition of drones contractors are noticing a greater decrease in delays when gathering data. This has a significant impact on the efficiency of the project.

Transportation

If the jobsite is difficult to get materials to by road, drones can do it by air, faster, safer and cheaper. Since drones do not have to obey traffic laws, they are able to make deliveries much faster and use fewer resources than traditional

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delivery methods. If smaller things like drawings or plans of a tall building need to be moved from floor to floor, drones can do it. This also allows companies to execute difficult inspections and keep track of everything that enters and leaves the job site.

Improved Overall Security and Surveillance

Drones act as an eye in the sky. They are being used to maintain the safety of employees. Drones also protect the site from theft and vandalism because they create a round the clock real time monitoring system. Since this use of drones is so effective, it has already been adopted by a number of construction companies like Kier, Costain, Balfour Beatty, Mitie, and Intersrve. Traditional security systems combined with drones will ensure the site is super safe.

Like Rachel Burger, Blake Anderson (15), wrote an article titled *7 Great Uses for Construction Drones*, which was published on Dronethusiast.com. His seven categories are Planning, Surveying, Showing Clients the Progress, Monitoring Job Sites, Inspecting Structures, Better Safety Records, and Keeping the Project On-Track and On-Budget. During the planning stages of construction, Anderson claims if there is a problem at the job site, the construction manager can use drones to employ eyes and ears if he is not able to travel to the site in time. Instead of having a surveying team bring out all their heavy equipment and expensive machinery, the job can be don't in a fraction of the time and money and with greater accuracy with a drone. Not only this, but with the right software, collecting data with a drone is a lot easier and is organized in a much more effective way. They create color coded contour maps of job sites that makes it easy to see where the site needs to be excavated or filled. Since drones are able to get places where people cannot, they are extremely useful when showing the project to the client, especially if the client isn't able to travel back and forth to the site as often as they would like. By using drones as a monitoring system, project managers are able to monitor progress and safety standards. They can also detect if anything is missing or has been stolen from the site. Drones are also being used after the actual construction is completed to inspect the structures and make sure they are not deteriorating from normal wear and tear or from the weather. A time-lapse or the building can be made from different views to ensure nothing is changing or getting dangerous. With vigorous monitoring, contractors are also able to make sure the project isn't going off track and ensuring it is staying on schedule and on budget.

DroneDeploy is one company that is capitalizing on this new drone technology. This company, which was started in 2013, makes drone software that is "transforming the way businesses collect, manage, and interpret drone data." They have created a mobile application for drone mapping that makes it easy to collect capture data. In less than 5 years DroneDeploy is used in 180 countries worldwide, powers more than 400,000 job sites, and has mapped over 30 million acres from customers. Their mission is "to make the skies open and accessible for everyone." Their user-friendly platform makes it easy for any sized company to use their program, which allows for scalable image processing, data storage, and real time sharable drone maps and 3D models. Mike Winn, DroneDeploy founder and CEO states, "We've removed the complexity associated with using drones. Two taps of a finger on a tablet, you can get a drone flying, capturing data, and coming back to land completely autonomously."

Brasfield & Gorrie (9) is one of the first general contracting companies to start using DroneDeploy's software. Through this partnership, DroneDeploy has been able to understand in more detail how construction companies are using drones, and what they need to improve upon. Since starting up in 1964, Brasfield & Gorrie has grown to have 12 offices and approximately 2,600 employees and have designed and built large projects like the Atlanta Brave's SunTrust Park stadium in Atlanta, Georgia. Reflecting on how the use of drones has affected their company, Brasfield & Gorrie's CEO Jim Gorrie states, "We can literally take weeks out of a schedule. Our projects are much higher quality than before, and they're safer. Over the last few years, you can see the efficiencies that are being gained by the use of drones and related technology. The future of drones is unlimited-we're going to see more change in the next five or ten years than we've seen in the last 50."

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IV. CONCLUSION

We have collected, studied, and analyzed the applications of technological tools currently used in AEC industry. There is no doubt that using drones to help with the construction process is taking over. The positives outweigh the negatives and provide a foundation for construction to be at a peak level of efficiency. Drones are there at the start of the project, by helping with surveying land, throughout the project, by communicating with the owner, and even after the project is over, by keeping up with maintenance and taking spectacular aerial images of the final result.

These advancements in construction have changed the way the word designs, plans, and builds all forms of construction. Even recently, over the past decade, amazing buildings have been built that have wowed millions of people using these technological advancements. It'll be amazing to look back in another ten years to see what technology did for the next decade.

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