Use Of Drones In Construction Industries: A Review

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Abstract: There are several uses for drones in civil engineering. Drones serve as tools to improve communication between construction stakeholders, increase site safety, conduct comprehensive topographic surveys, and enable aerial photogrammetry techniques for surveying buildings, bridges, roads, and highways. These characteristics make it easier to save money and time on projects. Among the many benefits of unmanned aerial vehicles in civil engineering include the ability to produce real-time aerial photography of construction sites and thorough overviews that reveal the area's terrain, obstacles, and assets. The purpose of this study is to examine how unmanned aerial vehicles are used in civil engineering. It also looks at the various types of drones used in construction and their relative benefits and limitations. Among the many Industry 4.0 technologies, drones have attracted a lot of interest in the construction industry, and their use is steadily increasing. The influence of drones on construction is a prime example of a cutting-edge technological advancement that may greatly expedite building projects while lowering the demand for capital expenditure and expertise

Keywords: Drones, UAV, Construction, Industry, Surveying

1. INTRODUCTION

Innovations in technology have caused a dramatic shift in the building sector in recent years. Drones have become revolutionary innovations that are changing how building projects are planned, carried out, and maintained. When equipped with sophisticated sensors, cameras, and GPS, drones can collect data in real time, produce accurate 3D models, and conduct remote inspections. This research paper aims to provide a comprehensive analysis of drone applications in the construction sector, highlighting their impact across different project stages and demonstrating the benefits they provide the sector.[1,2]

Drones have quickly gone from being a novelty to being indispensable tools in the construction sector. By using different kinds of drones, construction workers may improve workflow, improve project coordination, and lower risks. Equipped with LiDAR sensors and high-resolution cameras, surveying drones offer precise mapping, topographical evaluation, and site planning. Architects and engineers can make informed decisions on building placement, design optimization, and resource allocation thanks to these drones' ability to capture detailed aerial data and generate large 3D models. When assessing difficult-to-reach or dangerous areas on building projects, inspection drones provide a distinct advantage. [3,4]

These drones offer accurate and efficient inspections of buildings, equipment, and infrastructure since they are equipped with infrared cameras, high-resolution imaging systems, and artificial intelligence. By monitoring construction quality, confirming compliance with safety regulations, and quickly identifying structural flaws, inspection drones increase project transparency, reduce manual labor, and enhance overall results. Regular drone inspections help proactive maintenance programs by seeing potential problems early and avoiding expensive fixes. Drones improve the durability and endurance of constructed assets by performing in-depth evaluations of infrastructure, bridges, and buildings. Drone use during maintenance also makes it possible to identify and fix issues more quickly, increasing safety and decreasing downtime. Drone use in the construction sector is a significant step toward greater efficiency, safety, and sustainability. Construction professionals are able to make informed judgments, improve project outcomes, and optimize resource use by utilizing their expertise in data collection, monitoring, and inspection. As drone technology develops, it is expected to play a significant part in revolutionizing the building industry, promoting creativity, and making it easier to use smart, durable techniques.[4,5,6]

2.DRONE TECHNOLOGY

In addition to reducing the total time and cost of building projects, emerging digital technologies appear to increase productivity. Despite their widespread use in other industries including mining, public safety, military operations, scientific research, agriculture, and security monitoring, drones have just recently been included into the construction sector.[7,8]

Highways, bridges, roads, cell towers, high mast lighting, wind turbines, power transmission lines, building façades and roofs, surveying and mapping, construction supervision, wetland and environmental assessments, drainage and erosion analysis, traffic monitoring, and emergency services are just a few of the many uses for

aerial vehicles in the construction industry. act as some illustrations. Operators have the ability to share images with remote subcontractors, internal business people, and on-site staff.[9,10]
UAVs offer vital assistance and cost effectiveness by conducting thorough surveillance of far-flung and challenging-to-reach areas. According to this perspective, 360° panoramas show a real-time environment, while UAVs offer the best access. In addition to construction schedule and cost prediction, this comparison may be extended to incorporate real-time recording, reporting, billing, verification, and planning. Nowadays, UAVs provide a high level of automation, making it possible to visit previously unreachable regions and quickly gather enormous volumes of data. Drones may be divided into a number of categories, including surveillance drones, military drones, aerial mapping drones, and photography drones. On the other hand, airborne platforms may be used to determine the best way to categorize drones.There are four principal groups of drones classified by the type of aerial platform: fixed-wing drones, multi-rotor drones, single-rotor drones, and fixed-wing hybrid VTOL drones.[11,12]

3. USAGES

3.1 SURVEYS

An inspection is required for almost all building surveys in order to assess the structure's technical condition and find any flaws or malfunctions. Ascending to the peak is frequently difficult and requires scaffolding, ladders, or other support structures, which can be dangerous, expensive, and time-consuming. Using a small drone in these situations can save time and money while reducing health and safety hazards associated with evaluating roof structures and accessing difficult-to-reach or complicated regions of a building's summit.[13,14]

3.2 TOPOGRAPY

Planning complex and large-scale building projects requires consulting topographic maps. Errors in structure design that are not suitable for the terrain can be seen on topographic maps. Although topographic maps are useful for building projects, making them may be expensive and time-consuming. In these situations, drones are really helpful. For these processes, its capacity to quickly gather large volumes of data results in considerable cost reductions and lower project expenditures. Due to their capabilities, drones ensure project accuracy, timeliness, and financial compliance.[15.16.17]

3.3 SITE INSPECTIONS

Drone data is regularly available to builders, allowing for immediate integration into projects and accurate site progress tracking. This allows construction companies to avoid obstacles and delays while making the most of their time and resources. Project teams may find drone-assisted building site inspections to be a useful tool. Drones may be used by a skilled pilot to identify technical or construction flaws at the job site. They can also be used for inspections to make sure project goals are met. Drone use during reconstruction and plan modifications can save thousands of euros in costs.During damage assessment, drones improve safety by removing potentially dangerous locations or gaps from the building site. Among other things, drones may be used to visually inspect the rooftops of buildings that are still under construction, help create complex 3D models of new projects, and scan a construction site to ensure that it complies with the architectural design. Site inspections can be undertaken more regularly and include a greater territory with increased efficiency . Four main benefits come from using drones for building site inspections: improved data quality, less labor intensity in data collecting, and increased safety.[18,19,20]

3.4 MONITORING

Perhaps the most significant benefit drones provide to customers in the construction sector is their ability to see from the air from different places and at higher altitudes. When clients are unable to physically visit a building site, a continuous drone flight above the site is an effective way to track project progress. At daily, weekly, or monthly intervals, project developers may obtain a more thorough grasp of project progress by using a variety of high-resolution aerial pictures and HD-quality [21,22]

3.5 PHOTOGRAMMETRY

It might be difficult for a surveyor to get access to a suitable laser scanning site, such a roof structure, for scanning. In this case, the resulting point cloud could be inadequate. This restriction could be overcome by combining drone technology with laser scanning. Both terrestrial laser scanning and drone-based aerial photogrammetry were used. There were two stages to the measuring of this construction. While the whole top part of the building was selected for digital measuring using aerial photogrammetry, the full front of the building was set aside for digital surveying using terrestrial laser scanning.[23.24]

3.6 THERMOGRAPHY

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top part of the building was selected for digital measuring using aerial photogrammetry, the full front of the building was set aside for digital surveying using terrestrial laser scanning.[25,26]

4. DRONE TYPES

The construction industry uses a variety of drones for a range of objectives. Three types of drones, are shown in Figure 1. These drones are widely used in a variety of applications, especially in the construction and maintenance industries.[27]

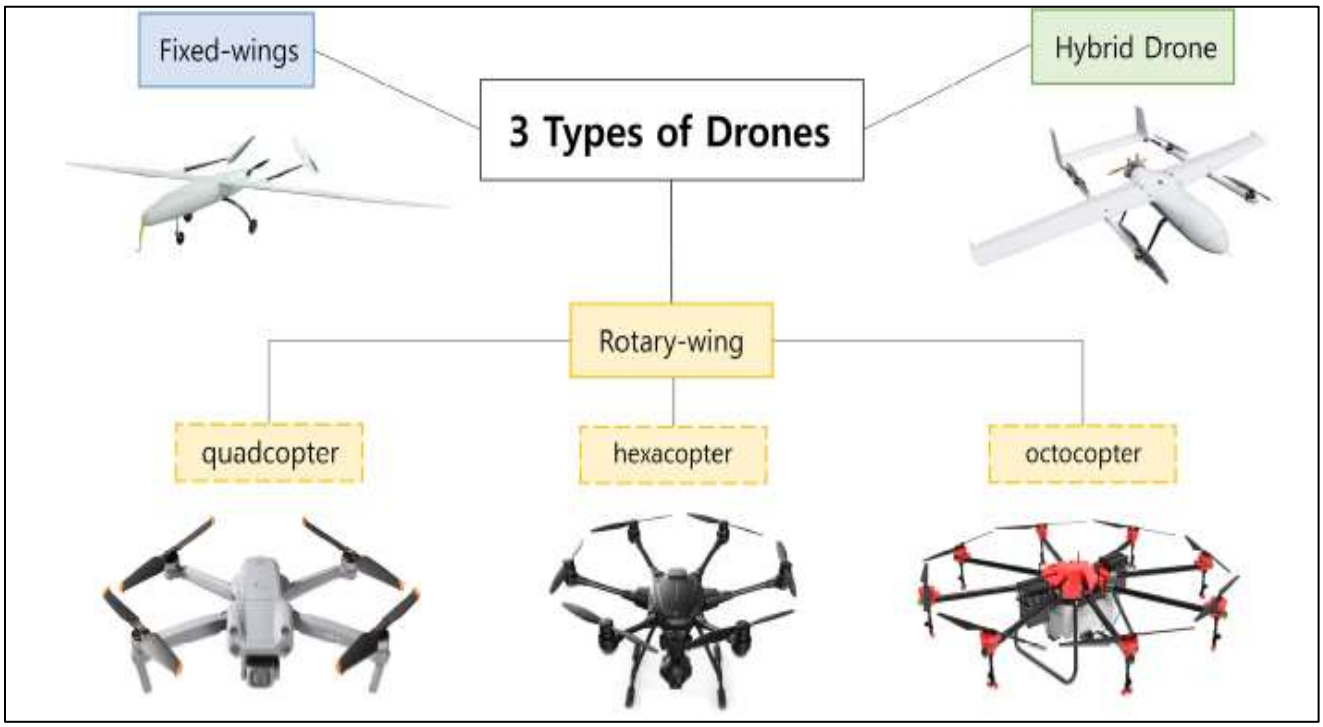


Figure 1. Three different types of drones used in construction industry.

4.1. FIXED-WING DRONES

Although they have certain disadvantages, fixed-wing drones offer several advantages for applications in civil engineering. Compared to rotary-wing drones, they have longer flight times. They can cover large regions and maintain a long-term aerial presence because to their efficient forward flying, which is useful for mapping and surveying projects. These drones' higher speed and endurance allow them to cover longer distances in a single trip. Their enlarged coverage area makes them appropriate for monitoring construction sites, conducting in-depth topographic surveys, and conducting aerial inspections.[28]

Generally speaking, fixed-wing drones are more stable than multi-rotor drones in windy conditions. They can maintain stability and capture excellent images even in inclement weather because of their aerodynamic form and ability to withstand gusts. Because of their higher cargo capacity, they can carry heavier equipment, such as LiDAR sensors and high-resolution cameras. This capability makes it possible to obtain comprehensive aerial data for precise construction site mapping, 3D modeling, and volumetric analysis. However, fixed-wing drones have a number of disadvantages to consider. Unlike rotary-wing drones, they have limited mobility and cannot fly or hover in small spaces.[29]

This restricts their ability to investigate vertical buildings or carry out up-close examinations in areas with a high population density. Additionally, compared to vertical take-off and landing (VTOL) drones, it requires a somewhat longer runway or open area for takeoff and landing. This might be a drawback in areas with limited space or challenging geography.[30]

4.2. ROTARY-WING DRONES

In the field of civil engineering, rotary-wing drones—also known as quadcopters and multi-rotor drones—have unique benefits and drawbacks. Due to its exceptional mobility and hovering capabilities, rotary wing drones are perfect for operations in tight spaces and up-close inspections of vertical structures. Their agility makes it easier to conduct thorough inspections of infrastructure and building sites, providing engineers and project managers with crucial data. Compared to drones with fixed wings, these drones need less takeoff and landing.[31]

They are capable of vertical take-offs and landings, obviating the demand for a runway or vast territory. This renders them more ideal for working on restricted building sites or places with constrained space. Compared to fixed-wing drones, rotary-wing drones are relatively easier to control. They are appropriate for small-scale civil engineering projects or businesses with limited resources since pilots may operate them with little training or experience.

4.3. HYBRID DRONES

The features and traits of both fixed-wing and rotary-wing drones are combined in hybrid drones. Like rotary-wing drones, they can climb and descend vertically, making it possible to operate in tight spaces and conduct close-up inspections. They may simultaneously switch to fixed-wing flying for the best forward propulsion, which enables them to traverse large regions and fly for longer periods of time. They are suitable for a range of civil engineering applications because of their versatility. Compared to traditional rotary-wing drones, hybrid drones provide longer flying times. By switching to fixed-wing flying, more distances may be covered in a single journey and energy can be conserved. This is useful for carrying out mapping, monitoring, and lengthy surveys that need extended flying times.[32]

Socially speaking, the drone is a safer alternative to human labor since it can traverse dangerous areas and reach high heights for vital tasks like surveying or inspection. By using drones to survey or check their areas of interest, land surveyors and inspectors can minimize direct danger exposure. By quickly identifying parameter violations or illegal entry to prohibited areas, drones may improve job site security. For site visitors and pedestrians navigating the workplace, this is especially important. Moreover, using drones to monitor transportation infrastructure—such as roads, bridges, and tunnels—could lessen the difficulties related to traffic control.[33]

5. VISION

Even though drones are widely used in civil engineering projects, there are still issues that need to be fixed in order to effectively utilize drone technology in this field. The low flying time and range is a major issue during the design, production, and maintenance stages since drone battery life is still a major constraint. Most commercial drones have short flight times, which limits their ability to scan large building sites or inspect long-distance infrastructure. Their total operating efficiency is hindered by this limitation, which makes frequent battery replacements and recharging necessary. Drones can now operate for longer periods of time and go farther thanks to continuous research and development efforts that are steadily improving battery energy density and recharging rates.

By eliminating the need for frequent battery changes, the use of alternative energy sources like fuel cells, solar panels, or wireless charging may increase operating efficiency. Strong winds, rain, or fog are examples of environmental conditions that might interfere with drone operations and affect project timeframes, which would be another obstacle for drones. Strong winds can cause turbulence in drones, and precipitation can damage sensitive electrical components, potentially leading to downtime and increased maintenance costs. Drones can withstand harsh weather conditions and continue to operate safely in challenging circumstances if they are built with robust frames, waterproof features, and advanced navigation systems.In order to promote innovation, optimize project management, and advance safer, more sustainable infrastructure development, civil engineers may use drone technology to improve safety at building sites, expedite monitoring procedures, conduct surveys, and produce 3D models.The length of flights and operations may be shortened by technological restrictions, such as battery life limitations.Aspects like take-off weight affect battery life, which in turn affects the kinds of cameras and sensors that may be used. Environmental factors, such as unfavorable weather and difficult terrain, can also hinder signals and connectivity. Examples of these include mountains, hills, underground tunnels, and severe weather phenomena like extreme temperatures, ice accumulation, high wind speeds, and heavy precipitation. Due to the lack of GPS and the requirement for more sophisticated sensing capabilities and sophisticated supporting algorithms, there are still several restrictions on the usage of drones in interior environments.[34]

In order to overcome these technological obstacles, manufacturers and customers from many sectors must work together to enhance drone capabilities for the construction industry and progress product research and development. Operating drones involves the potential of accidents with people, objects, and other aerial vehicles, according to society.Furthermore, because drone operations are vulnerable to GPS jamming and hacking, certain law enforcement agencies have voiced concerns about the security implications of drone use. This makes drones possible instruments for hostile actors to engage in cyberterrorism and other illegal activities. Strong security firewalls and ethical drone operating guidelines that specify flight goals, data collection parameters, data retention periods, potential privacy violations, and suitable risk and safety mitigation techniques can help address social issues.

6. CONCLUSIONS

The use of drones in the construction industry was compiled in this study. The study used the 5W2H approach to outline various drone applications over the course of a building project, analyze the benefits of drone use, discuss related issues, and provide a lifecycle cost summary. Based on many successful drone applications in the construction industry, the paper offered a comprehensive assessment of common practices. The results of this study set a standard for professionals and academics studying the state of drones in the construction sector. By providing industrial use cases and outlining other industrial 4.0 technologies that may be used with drones to maximize their utility, future research may build on this work.

One major technical advancement in civil engineering is the use of drones. Their use in the construction sector will unavoidably grow as they can quickly gather high-quality data and greatly reduce project team safety concerns. When incorporating new, cutting-edge technology into production or current operations, the construction industry is usually hesitant. In the quickly growing construction sector, unmanned aerial vehicle technology was quickly embraced as a way to improve safety and control while reducing expenses and time. Because of their many benefits, construction businesses are purchasing drones at a never-before-seen pace.

Throughout the whole construction project life cycle, drones have proven to be extremely useful for tasks like mapping topographic terrain, conducting building and land surveys, inspecting construction sites, providing remote monitoring, progress reports, thermal imaging documentation, and integrating with laser scanners. By reducing costs, time, hazards, and labor needs, drone capabilities give engineers, contractors, investors, and potential customers involved in building projects more confidence and certainty.

Drones equipped with advanced mapping technology and high-resolution cameras have revolutionized site surveys and aerial mapping in the design process. Construction personnel may use these drones to assess terrain, generate accurate 3D models, and gather precise data. As a result, the entire design process is enhanced and well-informed decision-making is made possible. In order to ensure safety, conduct inspections, and track progress, drones have proved crucial to the building process. Equipped with thermal imaging cameras and real-time video transmission, drones provide a quick and comprehensive evaluation of the job site, identifying any issues to improve output. Additionally, drones have demonstrated their efficacy throughout building projects' maintenance phase.

Regular drone inspections of infrastructure, buildings, and structures allow for the simple identification and diagnosis of flaws, enabling preventative maintenance, cutting expenses, and increasing asset lifespan. All phases of the building process have seen notable increases in efficiency, accuracy, and safety as a result of the use of drones in the industry. As technology continues to develop, drones are expected to play a significant part in revolutionizing the construction industry by empowering experts to increase productivity, reduce hazards, and create projects of the highest caliber.

Declaration of Competing Interest: The authors declare that they have no any conflict of interest.

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