

The application of drones on the construction site.

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Figure 1

Depending on the criteria of table 2, a drone can be chosen.

Type of drone	Fixed wings	Multicopters
Idle flying and vertical takeoff	No	Yes
Difficulty to control	Low	Medium
Mechanical complexity	Medium	Low
Electronic complexity	Low	High
Cost and complexity of post-crash repairs	Low	Medium
Range	Long	Short
Flight autonomy	Long	Short

To understand what a drone is, the drone should be analysed by its systems and subsystems. The result is shown in table 3. The diagram of the subsystems is shown in figure 2.

System	Subsystem	2 nd Subsystem	Function
Drone	Frame/ structure	Propellers	Staying in the air
		Gimbal	Calibration
		Batteries (single, multiple, intelligent)	Controlling the tilt
		Landing gear	Controlling the aircraft
		Power management unit (PMU)	Giving power to the drone
		Payload/ carrier arms	Battery log
			Landing
			Take off
			Carry-on and delivery
		Remote controller	Joystick
Return to home button	Returning home		
Antennas	Connecting to the drone		
Ground station			
Camera	Multispectral	Taking pictures, recording videos	
	thermal	Mapping	
	RGB	Aerial monitoring	
	hyperspectral	Surveillance	
	Full HD	Inspections	
Sensors	Infrared		
	GPS compass	Pinpoint location	
	IMUs	Maintaining altitude	
	Barometer		
	Transmitter	Connecting to the groundstation	
	Laser scanner	Waypoint navigation	
	LIDAR	Collision avoidance	
Operating mechanisms	GNSS		
	GLONASS		
	Flight control system	Allows the pilot to control the drone	

CONCLUSION

In general, we can conclude that the use of a drone can be really useful if it can be used on an efficient way, with the necessary knowledge and the necessary experience. The existing drones can offer the possibility to be adapted or converted into the most ideal construction drone. It is questionable whether a drone can be useful specifically for the construction industry. Due to the multifunctionality of current drones, certain functions can be optimized for the construction sector. It can be considered whether several drones can be used, each with their specific applications.

For the company Groep Van Roey it will be more interesting to start using drones by hiring a company to do the dronework. Within the company, there is not enough knowledge about drones, their applications and their possibilities. Afterwards, when the company has enough experience with drone use on the construction site, it could be interesting to set up their own drone department. This can concern an entire department or be limited to one or two people who perform all the dronework for all the construction sites.

Drones are becoming more and more available on the market for a variety of applications and with plenty of options. They are used for educational, recreational and professional purposes. Also in the construction industry, they are gaining in popularity, with applications such as **surveillance**, monitoring **site progress**, earth moving **measurements**, **inspection** of construction industry, etc., however, in its use as a mode of transportation, there are still a lot of problems.

Drones can be applied in all the phases of the construction industry. Most of the respondents, of the survey that was taken, suggested to use a drone in the **structural work phase** and the **work preparation phase** (figure 2).

For the structural work phase the tasks a drone can do (according to the respondents) are:

- Surveilling
- Site follow-up
- Mapping the construction site
- Inspection of roofs, hard to reach places...
- Calculation and monitoring of the earthworks
- Aerial monitoring

For the work preparation phase, drones can be used for:

- Mapping the construction site to link it to a 3D plan
- Calculations of the needed resources
- Topographic applications

The respondents saw opportunities in using a drone in the **completion and aftercare phase**. Most of the tasks a drone need to fulfill in this phase regard aerial filming and making 2D & 3D images for publication.

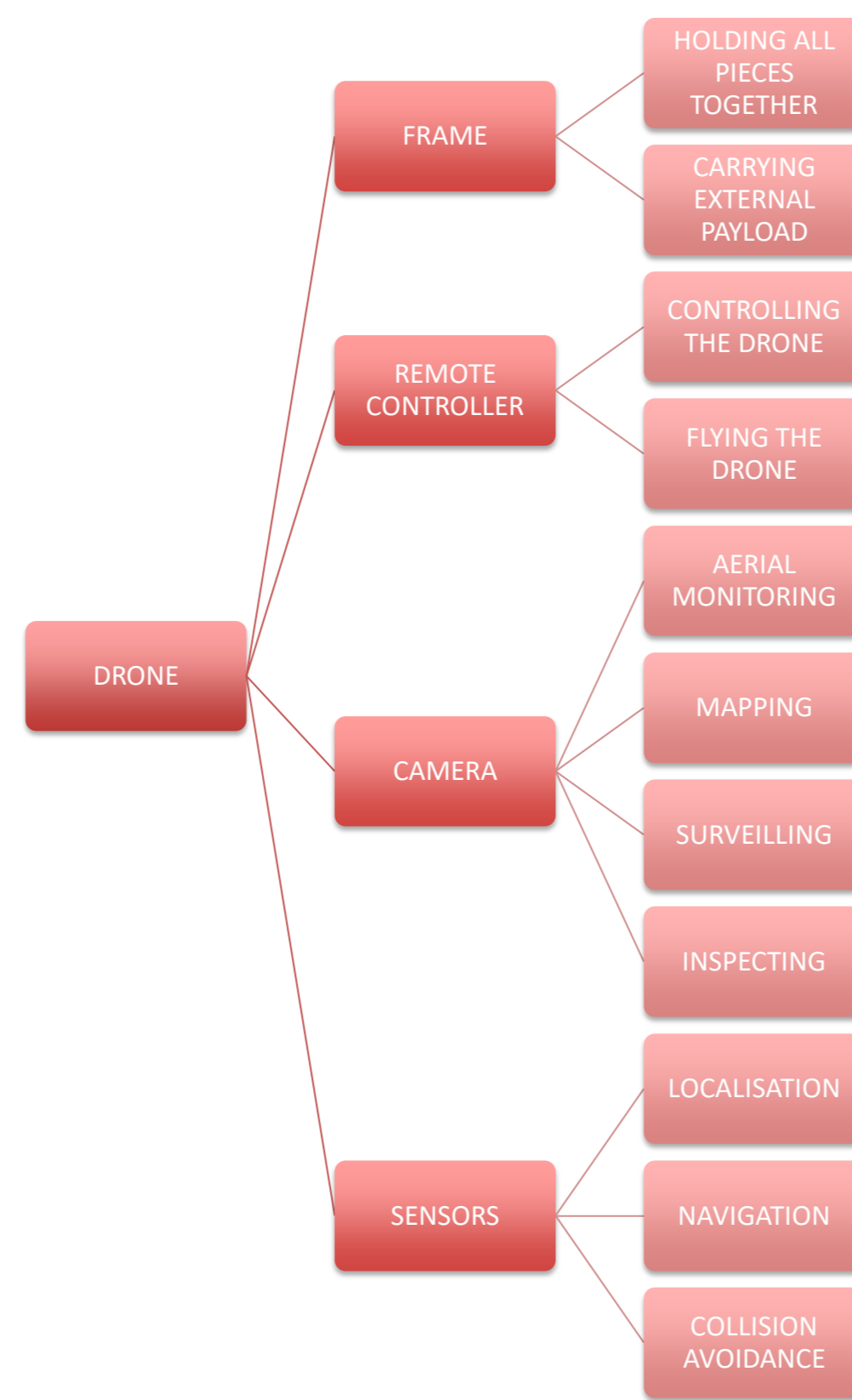


Figure : diagram of the subsystems of a drone

Role	Applications
project manager	- follow-up of earthworks, evolution of structural works, roofing works - camera images with an overview of the construction site - surveys by land surveyor - mapping of the site area, security mapping of delivered works - inspect difficult terrains - delivery of parcels - measuring existing buildings in 3D and then processing BIM afterwards - elevation images, time lapse, control high places - volume measurements of the earthmoving - promotional movies - detect insulation leaks - site supervision, applying small material to an extensive site that one had forgotten to bring to the workplace, useful for giving the current situation to the customer with aerial images
site manager	- photography, film recordings, camera surveillance, visualizing locations that are difficult for humans to reach - deliveries, aerial images (with heat cameras, problem areas could be quickly detected such as cold bridges, overheating, fire hazards) - determination of land quantities - 3D measurements, overall picture after completion or during the construction phase for real estate overview, leak detection - inspection in human-unfriendly environments, confined spaces, surveying geography, cartography (pre) inspection, exploration of hard-to-reach parts - taking photos for completion, AS-build, delivery of small equipment
architect	- site inspection, beautiful images upon delivery - inspection of roofs and other construction elements at height - photogrammetry of roof structures and façades (in combination with static scanning?) - measuring and mapping installations / constructions
workers	- surveillance
students	- security - parcel delivery, stock management, aerial monitoring - measuring earthmoving, determining soil removal - photogrammetry - 3D images, measurements - deliver parcels, mapping - guarding a site, moving materials, spraying fields, monitoring earthworks, monitoring the site, measuring infrastructure works
other	- timelapse of a construction site, commercial promotional images, site surveying - surveying the terrain linked to a 3D plan to create a site layout plan - inspection of roofs and façades - transportation of goods, security - record the progress of the site - topographic applications on the construction site

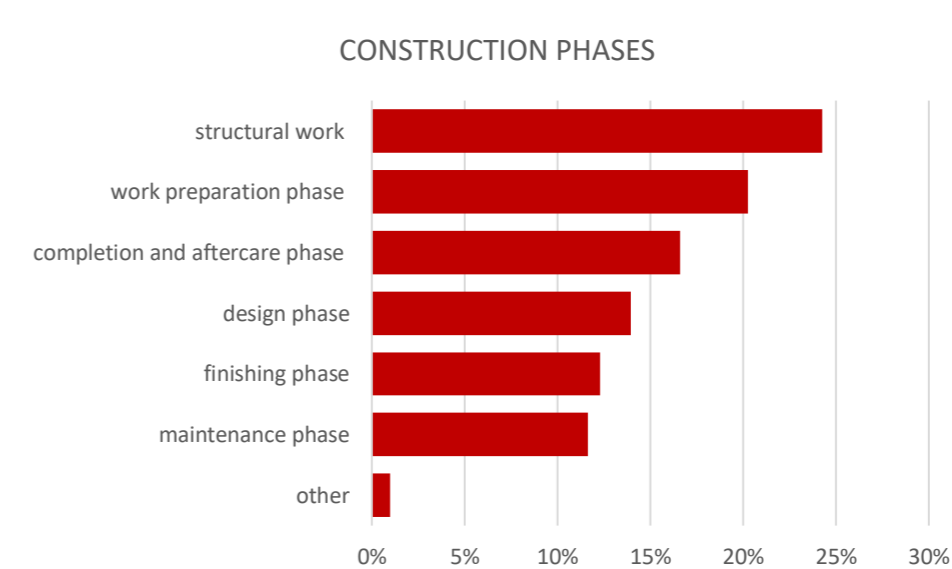


Figure 3: results of the survey according to the construction phases in which a drone can be used.

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Figure 1: „Biblus,” 2020. [Online]. Available: <http://biblus.accosoftware.com/en/drones-in-construction-to-support-bim-processes/>.
Table 2: F. Corrigan, „DroneZon,” 19 Novembre 2019. [Online]. Available: <https://www.dronezon.com/learn-about-drones-quadcopters/drone-components-partsoverview-with-tips/>. [Geopend February 2020]