

The Use of Drones in the Operation and Planning of Transit in Belo Horizonte

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Abstract: BHTRANS - Empresa de Transportes e Trânsito de Belo Horizonte S/A is the Belo Horizonte City Hall company responsible for the planning, execution, inspection, and control of traffic and the road system in the municipality of the Brazilian city of Belo Horizonte. The use of drones in the performance of these functions began in 2023. The equipment is used for the visualization and control of traffic incidents, observation and monitoring of demonstrations, large-scale events, and construction works. The images can be transmitted to the City Hall Operations Center in real-time and enable greater assertiveness in traffic operations to define detours and alternative routes for traffic and transport. It is also used in the planning of interventions in the road system, such as: project evaluation, volumetric counting, and queue measurements. This work aims to present the project implementation process and the results achieved.

Key words: drone, traffic, planning, operation, signalling

1. Holistic Development

BHTRANS — Empresa de Transportes e Trânsito de Belo Horizonte S.A. aims to plan, organize, direct, coordinate, execute, and control the provision of public services related to traffic, transit, the road system, and public transport inspection in the municipality. The company seeks, every day, to offer citizens a service of better quality and as transparently as possible, with safety and efficiency. In this sense, the company understands that the search for new technologies for the performance of its duties is a permanent need. Among the directorates responsible for the company's duties, the Directorate of Regional Action and Operation (DRO) has, among others, the duties of directing planning and special operations in the road, transport, and traffic system; planning and operationalization for the implementation of traffic detour projects for the execution of works and events

on public roads, executing transport and traffic contingency plans, and maintaining favorable conditions for the safety and fluidity of vehicle and pedestrian traffic. The Directorate of Road System-DSV is responsible, among other duties, for ensuring the safety and fluidity of vehicle and pedestrian traffic in the road system, preparing and implementing projects related to the road system and traffic engineering; implementing and maintaining horizontal and vertical signalling, traffic simulation activities for vehicle and pedestrian circulation projects, and preparing traffic light plans.

2. Definition of Drone

UAVs (Unmanned Aerial Vehicles) or Drones, as they are popularly known, are equipment equipped with fixed wings or rotors that operate without the physical presence of a pilot on board, with control carried out through data transmission systems (a radio frequency link), which allow the aircraft to be commanded remotely. They are devices that can contribute to expanding monitoring capacity,

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increasing the potential for collecting essential data and information for traffic planning and operation.

A drone is any vehicle that has the capacity to perform tasks autonomously, whether terrestrial, aquatic, or aerial. This capability is provided by embedded systems (controllers, various sensors, and other electronic components), which are responsible for performing tasks and maintaining all the functions for which the equipment was designed.

Regarding architecture, there are basically three types of Drones/UAVs. The main difference between them stems from the way they sustain themselves in the air. Thus, in general, the equipment can be equipped with a rotor (helicopter) or multirotors (quad, hexa, or octocopter), as shown in the example in Fig. 1, and fixed wings or balloons.

3. Regulation

The use of drones depends on authorization from the regulatory bodies of the Brazilian airspace. The Department of Airspace Control (DECEA) has the mission to plan, manage, and control activities related to airspace control, flight protection, search and rescue services, and telecommunications of the Aeronautics Command [3]. As the central organ of the Brazilian Airspace Control System, DECEA is responsible for providing the necessary means for the management and control of airspace and air navigation services in a safe and efficient manner, as established in national standards and international agreements and treaties to which Brazil is a party.

DECEA published in November 2009 the AIC (Aeronautical Information Circular) number 29, which dealt with the access of UAVs (unmanned aerial vehicles) to Brazilian airspace. The legislation was replaced by AIC 21/10, in September 2010, which besides modernizing nomenclatures (it started adopting the terms RPA and RPAS), also dealt more completely with the use of such aircraft in general air circulation. In November 2015, ICA 100-40 [2] was published, a document that regulated remotely piloted



Fig. 1 Multirotor Drone [1].

aircraft systems and their access to Brazilian airspace. The Regulation edited by the Department of Airspace Control (DECEA) underwent a revision in 2016, when DECEA Ordinance No. 282/DGCEA of December 22, 2016, was issued, which approved the reissue of the Aeronautics Command Instruction (ICA 100-40), in force until the beginning of 2019 (pp. 2-3). On January 3, 2019, a new version of the document was published, and the acronym UAS started being used to designate Unmanned Aircraft Systems (replacing the acronym RPAS, or remotely piloted aircraft systems). The documents were updated on January 2, 2018, when they came to be designated as AIC No. 24/18 and AIC No. 23/18, respectively; subsequently, they underwent a new revision on June 11 of the same year, currently being the reference standards in the country for the weight (MTOW). On the other hand, the establishment of general requirements for pilots and observers, as well as for operations with aircraft, is the responsibility of the National Civil Aviation Agency (ANAC), which also regulated the use of UA (Unmanned Aircraft) in its sphere of competence by Resolution No. 419 (RBAC-E 94 — General requirements for unmanned aircraft for civil use) of May 2, 2017; besides establishing rules for pilot and observer licensing, defining responsibilities and general rules for operation with unmanned aircraft, the equipment was classified according to its maximum takeoff.

The current regulation in force is DECEA Ordinance No. 928/DNOR8 of May 15, 2023, which “Approves the reissue of ICA 100-40, Instruction on ‘Unmanned Aircraft and Access to Brazilian

Airspace””. The standard incorporated definitions related to new procedures and parameters, including: SARPAS Administrator, Flight Restriction Zone (FRZ), Aeroagricultural Operation, Atypical Operation, Aerial Survey Operation, Confined Area Operation, Standard Operation, Aerodrome Operator, AIS Product, SARPAS Section, Tactical SARPAS, Coordination Agreement, Aerodrome Surrounding Zone, and Helipad Surrounding Zone. The concept of the Shadow Principle was replaced by Operation in the Vicinity of a Structure [2].

3.1 Inspection and Control

3.1.1 National Telecommunications Agency — ANATEL

The National Telecommunications Agency — ANATEL is the body responsible for regulating and supervising the execution, commercialization, and use of services, and the implementation and operation of telecommunications networks, as well as the use of orbit resources and radiofrequency spectrum in the Country. The use of unmanned aircraft systems in the country requires equipment certification by the regulatory agency through a specific administrative procedure, since it uses radiofrequency technology for communication between its components. The rules are those laid down in Resolutions No. 465/07 and 635/2014, issued by the regulatory agency.

3.1.2 National Civil Aviation Agency (ANAC)

The National Civil Aviation Agency (ANAC) is the body responsible for acting as the civil aviation authority in the country, in order to regulate and supervise civil aviation activities, aeronautical and airport infrastructure in Brazil. It is ANAC’s responsibility to manage the Brazilian Aeronautical Registry (RAB) with the functions of registering aircraft, as well as issuing Certificates of Registration (C.M.) and Airworthiness (C.A.) for civil aircraft subject to Brazilian legislation. It is also ANAC’s competence to proceed with approvals and issue certificates, statements, endorsements, and

authorizations related to activities under the competence of the civil aviation flight safety system, as well as crew licenses and certificates of technical qualification and physical and mental capacity, observing the standards and rules established by it.

3.1.3 Department of Airspace Control (DECEA)

The Department of Airspace Control (DECEA), an organ subordinate to the Aeronautics Command, had its duties defined by Decree No. 3,954 of October 5, 2001. The department is responsible for acting as the central organ of SISCEABE (Brazilian Airspace Control System) and aims to plan, manage, and control activities related to airspace control. In addition, among other duties, it acts to provide the necessary means for airspace management and control and the air navigation service, in a safe and efficient manner.

3.2 Registration and Cadastre of Drones and Pilots

The aircraft must be registered with SISANT, a system of the National Civil Aviation Agency (ANAC). The registration is valid for 24 months. Pilot registration is done at DECEA: <https://sarpas.decea.mil.br>.

3.3 General Rules for Access to Airspace

ICA 100-40/2023 defines that an unmanned aircraft may only access Brazilian Airspace after the issuance of an Authorization by the regional body responsible for the airspace where the flight will take place. Flight operations carried out based on the conditions must be requested by the aircraft operator directly in SARPAS (System for Requesting Access to Brazilian Airspace) by Unmanned Aircraft, at least thirty minutes in advance of the start of the intended operation. The request for access to Brazilian airspace must be made in SARPAS by the aircraft operator to the Regional Body (CINDACTA I, II, III, and IV and CRCEASE) responsible for the area in which the intended operation will take place on the DECEA page: www.decea.mil.br. The standard also defines the

Rules for Access to Brazilian Airspace, such as: traffic height, operation around structures, over populated areas, over security areas, etc.

4. Use of Drones in BHTRANS

The acquisition of the first drone by BHTRANS was made as a pilot project, to evaluate the suitability of the equipment to the company's needs and eventual subsequent expansion of the fleet. The equipment acquired in November 2023 had simplified technical specifications, aiming to reduce the initial project cost and avoiding the acquisition of functionalities that might not be a priority for the company.

The Directorate of Operations and Regional Action

(DRO) gained an important tool for the visualization and control of traffic and transport incidents in the municipality of Belo Horizonte, safely for traffic agents. The equipment allows the observation and monitoring of demonstrations, large events, and works, of saturated streets and avenues or those with accidents. The images allow an expanded view of the situation, with the sending of real-time images to the COP (Operations Center of the Belo Horizonte City Hall), and with a privileged view (from above) enabling more assertiveness in decision-making to define detours and alternative routes for traffic and transport, as well as generating more reliable information for the population.

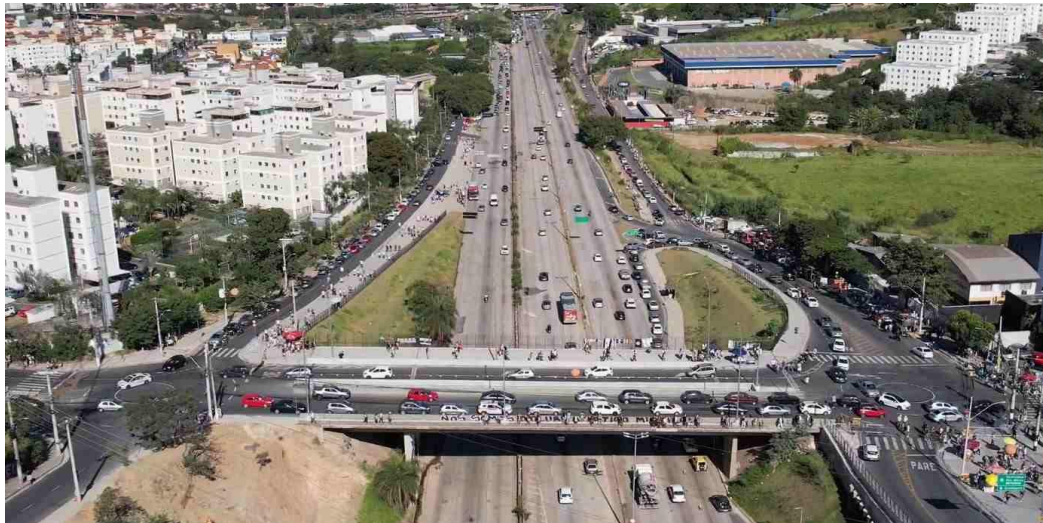


Fig. 2 Football game operation at MRV ARENA.

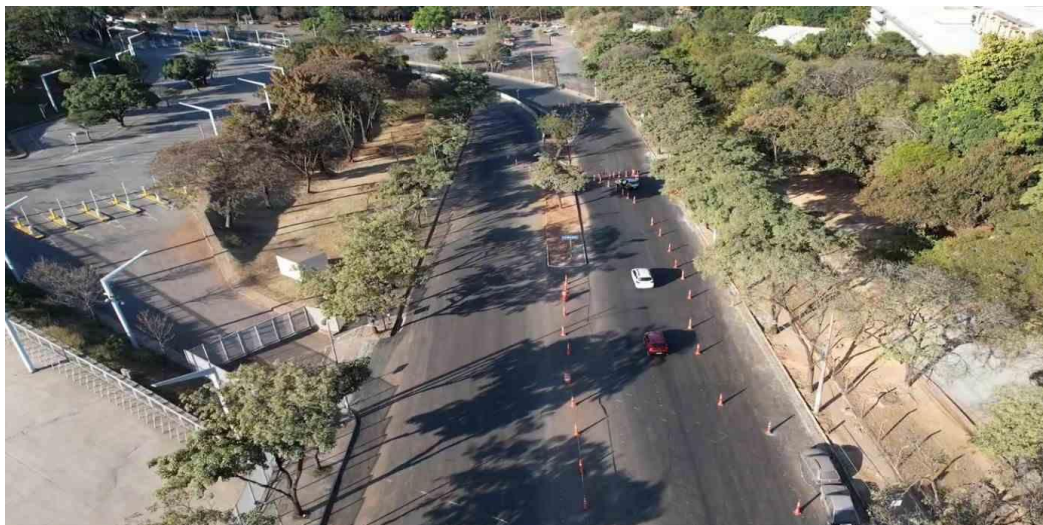
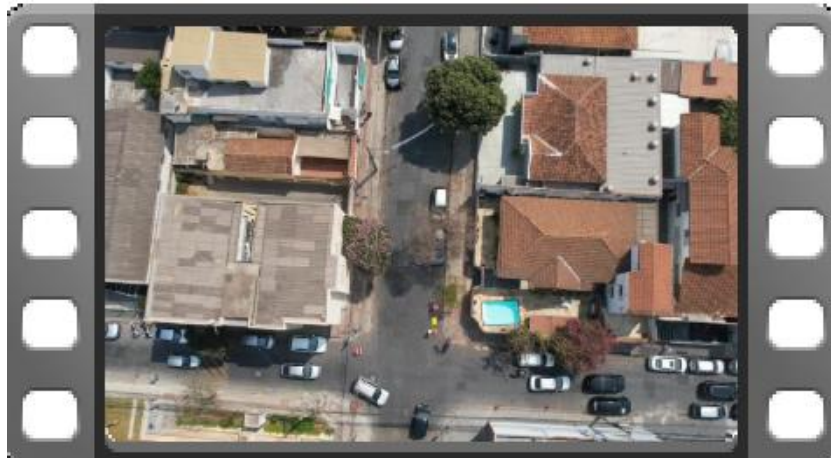


Fig. 3 Monitoring of works for the Stock Car Race event BH circuit.



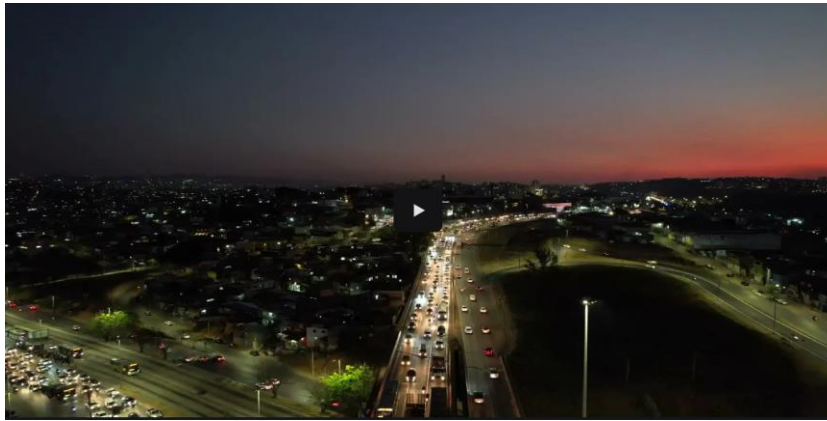
Fig. 4 Monitoring of resurfacing works on the MOVE Vilarinho BRT.



Video 1 Circulation alteration on Turfa St. [4].



Video 2 Closing of Sapucaí St. [5].



Video 3 Mineirão Operation [6].

In the Directorate of Road System (DSV), the drone is used to collect traffic data for the preparation of proposals for interventions in the road system, such as: queue measurements, volumetric counting, evaluation of implemented projects, with photo and video

recording, pre-project area evaluation, post-project results evaluation, allowing comparisons with images and footage of the locations before and after implementation.



Fig. 5 Implementation of islands and new crosswalks at the intersection of Contorno Av. and Getúlio Vargas Av.

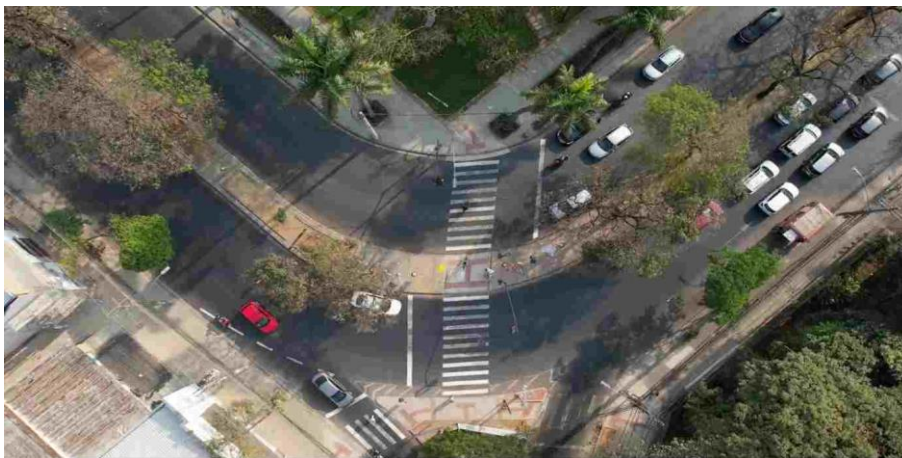


Fig. 6 Implementation of a new crosswalk.



Fig. 7 Educational campaign.



Fig. 8 Stock car race works.

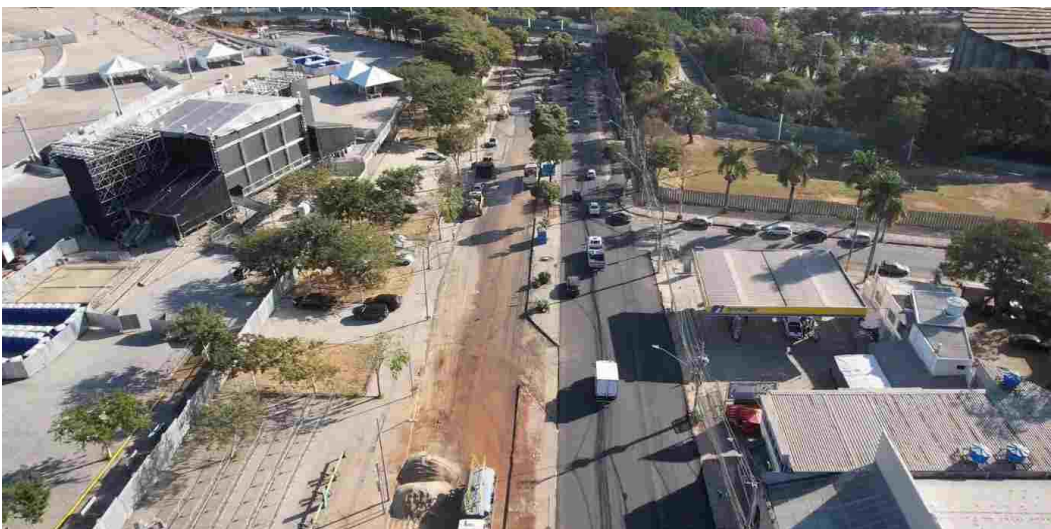


Fig. 9 Stock car race works.

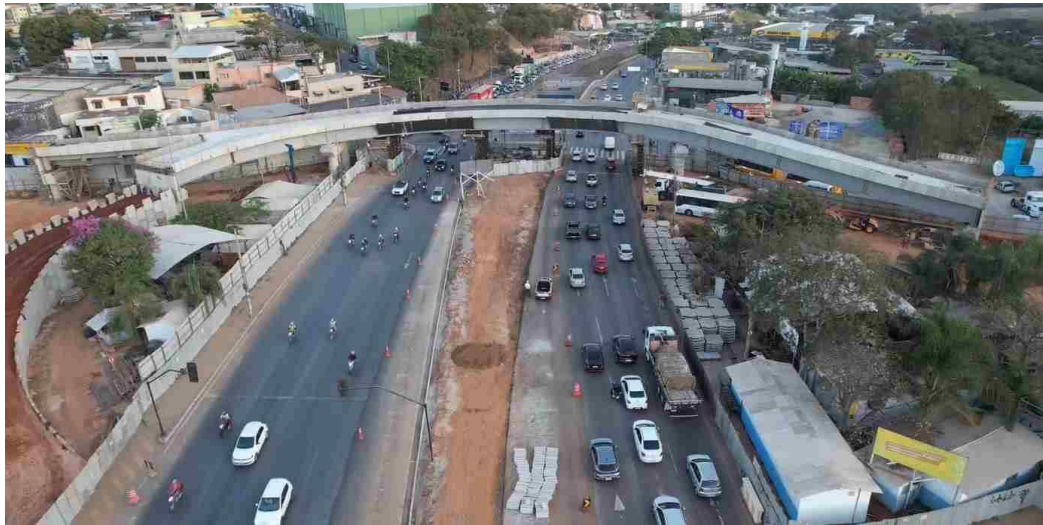


Fig. 10 Monitoring of works on the Waldomiro Lobo Viaduct.



Fig. 11 Monitoring of works on the Waldomiro Lobo Viaduct.

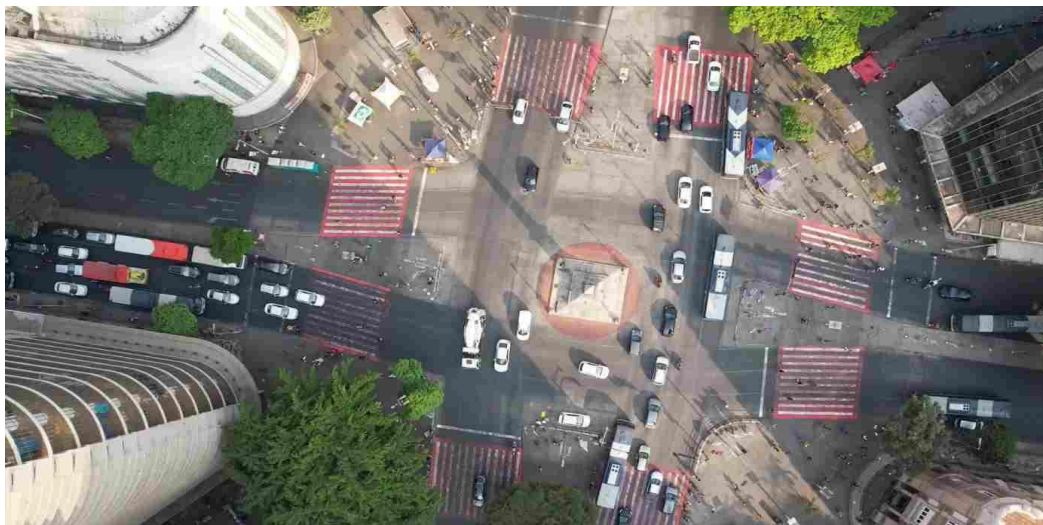


Fig. 12 Seven square monitoring.

5. Conclusion

Acquired in November 2023 as a pilot project, the drone represented an evolution for BHTRANS in traffic planning and operation in the municipality. The new technology proved to be fully aligned with the company's needs. Operations in large events, demonstrations, special operations, and accidents were optimized with the equipment. Also, the planning and implementation of construction projects and horizontal and vertical signalling were facilitated, by easing the diagnosis of the problem and the evaluation of the implemented solution. Validated as a pilot project, the expansion of the drone fleet is pending due to current budget restrictions.

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- [6] Video 3: Operation Mineirão, Youtube, accessed on 25/09/2025, Duration 0':37", available online at: https://youtu.be/J4-ecwJw_9o.