ANALYSIS OF THE POTENTIAL USE OF POINT CLOUD COLLECTED FROM UAS FOR BIM MODELING AND SAFETY SYSTEMS ANALYSIS

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BACKGROUND

Safety is one of the biggest concerns of construction around the world Zhou et al. (2013). From the lean view, poor safety is a form of waste, since injuries are costly not only in terms of human suffering, but also in terms of worker compensation costs, lost time, lost productivity, and higher employee turnover (Nahmens and Ikuma, 2009).

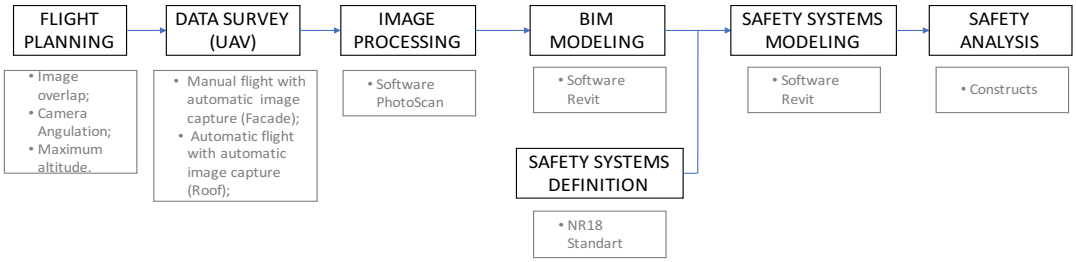
According to Guo et al. (2017) safety planning is based on a team meeting in which job hazard area are identified by imagining construction processes with the aid of 2D drawings, schedules, safety rules and experience. Besides that, the traditional safety management tools have failed to recognize hazard conditions, specially related to work at height, and new mechanisms are necessary to insure the ability of workers to work safely under such circumstances (Saurin et al., 2005). In reason of this, recent studies highlight that the use of emerging technologies can collaborate with the safety planning, errors correction and detection, being essential in the accidents prevention in construction sites (Zhou et al., 2013).

The BIM platform has been adopted primarily in phases of design and construction of new buildings, with little representation in existing buildings (Volk et al., 2013), and related to the safety, studies have developed applications such as safety planning and risk assessment (Hammad et al., 2012, Park and Kim 2013), although the definition and planning of safety requirements in under construction buildings has been little approached, despite the high degree of risk accidents, especially for services in height.

Thus, this study seeks to understand how the UAV images can support on the generation of BIM model of the current stage of construction for decision making about safety planning and definition of the safety systems.

RESEARCH METHOD

The research strategy adopted was the case study, developed in an educational building under construction, consisted of 7 floors (8131.18 m²). The main stages are described in the following figure.



For the analysis, three constructs were considered: (a) ease of creation of the BIM model based on point cloud (registration of the facade and safety systems); (b) quality of the model (absence of visual inconsistencies and level of detail of the point cloud); and (c) applicability of models for safety perspective.

RESULTS

For the analysis of the ease of BIM model generation, the time required for acquisition, processing and modelling was taken into consideration. The time of acquisition and processing of images to generate the point cloud (Fig. a) was 6,5 hours, the parametric modeling of the under-construction building (Fig. b) required 5 hours and the safety systems modeling (Fig. c) required 4 hours, with a total of 15,5 hours of work to obtain the final products. However, it is worth mentioning that only the external areas of the building (facade and roof) was collected with UAV.

(a) (b) (c)

The process of modeling was made by visual reference provided by the point cloud, allowing the definitions of the levels of buildings floors, thickness of structural elements (pillars, beams and slab) in the facade, as well as the height of external masonry. Beyond the building, the modeling of existing ramps, parking and natural terrain was carried out. In comparison with the usual survey methods, the point cloud generated by the pictures taken with the UAV enabled a faster survey of the under construction building, significantly reducing the time for information gathering.

Concerning the quality of the BIM model, the point cloud generated presented good quality with few visual inconsistences (such as, distortion, occlusion and shading) and a good level of detail (point cloud with good amount of points). These two factors are essential for the BIM modeling, allowing the extraction of more accurate information.

The use of BIM for safety analysis is justified by the ease of hazard identification and risk assessment of actual working conditions by promoting increased transparency of the safety process. Through the BIM model, it was possible to select the better safety systems to be applied. For the openings on the slab, a wood guardrail with 1,20 meters was adopted according to the Brazilians rules; in the edge of the slab, a lifeline system for keep the worker safe and allow the movement along the slab was designed; for prevent fall of materials, three safety trays, positioned in the first, fourth and seventh floor were planned. Also, according to the 3D model based on real conditions was possible to define the jobsite layout (such as, temporary installations, which was located on the external area of building), to choose the better positioning of vertical transport equipment (elevator, winch, among others) and the principal route of access of vehicles and equipment.

Among the benefits provided by the safety systems model, it is worth it to highlight the possibility of carrying out the quantitative takeoff of the modeled elements, providing a greater data precision on budget and planning. Despite the possibility of the cost estimate of the safety systems, the absence of cost composition for safety elements is still a barrier on construction industry.

Another possibility is to establish an assembly planning concerning the protective equipment (such as, safety tray) considering the sequence of installation, due to the high risk of fall accidents during the assembly or disassembly activities of the pieces. In addition, the model of the safety elements can be used for pre-fabrication of the systems adopted, such the floor of the safety trays and guardrails.

CONCLUSION AND CONTRIBUTIONS

The main contribution of this study is related to the application of UAV and BIM on safety in construction sites, by means of support on decision making on safety planning and definition of the safety systems for existing building, in particular, the fall prevention systems, the vertical transport equipment and route access. Therefore, these technologies can corroborate to the improvement of work condition and cost reduction, due to the previous definition of the systems and possibility of risk assessment based on real situations.

The results show that the quality of the point cloud is an important factor, since a greater level of detail allows the creation of a more reliable BIM model. In addition, the integration of the photogrammetry with BIM presented high potential, since its low cost and the good data quality and precision concerning to the current building for the creation of the BIM model. Further studies need to be carry out in more complex building project for new recommendations.

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