Implementation Photography as a Media and Supports in Construction Era 4.0 at the Civil Engineering for the Construction Design to Face Tidal Floods Due to Global Warming

S Hermawan¹ and S Leman²
¹Civil Engineering and Planning Department, Petra Christian University, Siwalankerto Street No.121-131, Surabaya, East Java - Indonesia
²Professional Engineer Program, Petra Christian University, Siwalankerto Street No.121-131, Surabaya, East Java - Indonesia
Corresponding author: shermawan@petra.ac.id

Abstract. Global warming causes climate change with extreme intensity, and other impacts are rising sea levels along with increasing global temperature variability. The research problem located at a remote area in Sidoarjo Regency, East Java Province Indonesia. On December 06, 2017, dozens of houses flooded as high as 60 to 70 cm, resulting in losses of 5 billion rupiahs. Then, it needs to conduct research and design for answering this challenge, but the measurement data was expensive. Thus, the goal of this study, as well as a challenge as Indonesian Engineers, is responsible for taking action through the professionalism of engineers with science and technology by implementing the photography technically. In construction 4.0 era, the new method of aerial photography had introduced. The methodology in this study carried out by making nearshore bathymetry maps with drones along with taking pictures, then it processed and analysed with MenciAPS software and ArcGIS, which was cheaper and safe than using an aeroplane. The outcomes show that the situation nearshore bathymetry map can support measurement data. It can help improve the quality of an engineer, because of the self-development has been done. Thus, the results obtained can be used as a reference for inter-community planning.

Keywords: bathymetry, civil engineering, construction 4.0, photography, photogrammetry

1. Introduction
Global warming causes the melting of the polar ice caps so that it shows that rainfall and strong winds will be more terrible, along with hot weather and snowstorms become more extreme, one of the more pronounced impacts is rising sea levels and increasing global temperature variability [1]. In Indonesia, the sea level rise concerning the Center for Research and Development of Marine and Coastal Resources of the Ministry of Maritime Affairs and Fisheries in 2014 reached 0.73 - 0.76 m per year [2]. One of the impacts of sea-level rise that occurred was Rob Flood.

On December 6, 2017 dozens of houses at seaweed cultivation zone in RT 1 and RW 2 RW 06, Kupang Village, Jabon District, Sidoarjo Regency, were flooded as high as 60 to 70 cm, the flood caused by Rob or tidal seawater [3]. This occasion identified as the main problem. Rob flooding that occurred caused the collapse of embankments in several hamlets which resulted in the loss of fish in ponds and seaweed that failed to harvest resulting in losses of 5 billion rupiahs [4]. Thus, to solve this
problem, it needs to get bathymetry data to design the appropriate construction to solve this problem. However, this measurement data is still very expensive.

Regarding the Spirit of National Engineer, Indonesian Engineers as the Indonesian nation, are responsible for taking on social responsibility roles through the professionalism of engineers with science and technology and solving various problems faced by the community [5]. Therefore these research goals are to figure out the cheaper method by the implementation of photography as media and support in construction era 4.0 at civil engineering for the construction design to face tidal floods due to global warming, along with to be approached with the science of photography relating to the use of drones which is one of the fields in the world of photography, namely aerial photography.

The use of drones itself is one of the phenomena in the development of photography in industry 4.0, where before the creation of drones, photogrammetry or aerial photography was carried out using aeroplanes or helicopters and sometimes carried out by freefall from existing planes or helicopters, it certainly requires a significant cost large and threatens the safety of those who carry out these activities [6]. This research will maximise photogrammetry theory and bathymetry mapping using basic photography knowledge and techniques on drone cameras.

2. Research Theory and Method
In this research, the use of a drone namely DJI Phantom 3 Advanced in which the camera sensor is measuring 1/2.3 inch, as a tool to obtain data in the form of photographs of the research location, required exposure settings of the drone camera before taking aerial data of the research location.

This study also uses the Weather Station to obtain data on temperature, wind, humidity, light strength, UV (ultraviolet), and UVI (ultraviolet index) mounted using a tripod on a river embankment. With the research location in sub-district Tegalsari, the Weather Station reads every 5 minutes. MenciAPS (Aerial Photo Survey) is used to combine the photos that have been taken by the drone to see the Digital Terrain Model (DTM) and for further process use ArcGIS to see the Digital Terrain Model section, ArcGIS is a software released by the Environmental System Research Institute (ESRI). ArcGIS is the platform that consists of the number of software, namely Desktop GIS, GIS Server, Online GIS, ESRI Data, and Mobile GIS.

2.1. Photography
Photography comes from English: photography, which comes from the Greek word’s "photos": light and "grafo": painting/writing, thus photography is writing or painting with light media [7]. Photography provides evidence that something exists or an event occurred. In the early days of photography, the main function of the camera was as a natural photocopier, and it closely resembled what the human eye saw [8].

2.2. The direction of light
According to Belajar Fotografi [9], the direction of light falling on the subject will greatly affect how the photo looks. The direction of the light determines the character of the light itself as well as determines the impression and dimensions that it wants to cause to the subject, and then as a whole, it forms our photo.

2.3 Exposure triangle
In photography skills are needed in adjusting the light or exposure. According to Cooke [10], the exposure triangle is a common way to link the three variables that determine photo light: aperture, shutter speed, and ISO. One must balance all three to achieve the desired results, adjustments that require adjustment from at least one of the others.

2.4 Camera sensor
According to Crisp [11], the size of the sensor the camera has determines how much light is used to make an image (see Figure 1). In very simple terms, an image sensor (the digital equivalent of film negatives that used to be on a camera) consists of millions of light-sensitive points called photosites
which are used to record information about what is seen through the lens. Therefore, a larger sensor can obtain more information than a smaller one and produce a better image.

![Sensor Size of the Camera](image.png)

**Figure 1.** Differences in Sensor Size of the Camera [11].

2.5 *Purpose and characteristic of photography*

According to Indarto [12], photographs produced by each person have different goals, but in making a photo that can be said to be successful, one must pay attention to several things. Photography in its use has several purposes, namely: documentative, illustrative and interpretive.

2.6 *Aerial photography and Photogrammetry*

Aerial photography is taking photographs using aeroplanes or other flying objects or poles for an area from the air [13]. Photogrammetry, Photogrammetry is the science of making reliable measurements using photography and especially aerial photography (as in surveys) [14].

2.7 *The benefits of photography in the civil engineering world*

According to Fisk [15], here are some of the benefits of photography relating to the types of photography in the world of civil engineering: public relations photography, photo documentation of safety equipment, time-lapse photography, and photogrammetry which has a function for mapping. In industrial 4.0, now a photo file can store a lot of information, not only information about light and colour but also information about time, date, and location can store in the form of a geotagging location [16].

3. *Results and discussion*

To solve the problems that occur in Tegalsari Hamlet in Kupang Village, Jabon Subdistrict, Sidoarjo Regency, East Java Province, of course as Engineers, they can develop themselves by studying photography, photogrammetry, bathymetry, drones, and analysis using Manci APS software, and ArcGis software. In the implementation of photogrammetry for bathymetry mapping, the area was divided into five segments because the length of the river under study reached ± 800 meters.

In the implementation of aerial photo shooting, it should note in the existing camera settings, and good quality aerial photographs can be obtained by manually adjusting the photo and performing calibration as much as every two segments once to save battery life and time efficiency considering the drones used are only able to fly around ± 15 minutes for 1 battery. In this research, it found that the optimal height for the drone to produce good aerial photography that can be processed properly on the Manci APS software is 80 meters.

The understanding of the direction of light and camera settings help this research take photos that quite well controlled and the non-uniformity of light and colour in the image reduced quite a lot, this can be minimised by manually adjusting the drone's camera by understanding the exposure triangle and setting the lightmeter at -0.7 [17]. Figure 2 showed that the reflection of sunlight in quite minimum.
This was carried out to obtain a stable photo light in the hope that when combining existing photo images can look good and can analyse with software to the occupied. The results of the photos in the study area by dividing into five segments are 352 files. As can be seen in Figure 2, the result of processing research data uses Menci APS software to get bathymetry map modelling, so that there can be a map of existing river bed contours.

![Figure 2. The Results of Merging Drone Photos with Menci APS Software.](image)

After merging photos successfully, a Digital Terrain Model (DTM) can perform on Menci APS software, the result can be seen in Figure 3. On the results of this DTM, there are some photos of river areas that were not detected by Menci APS software.

From the results of the existing photogrammetric data processing, it still cannot be fully processed even though the quality of existing photos is almost uniformed which caused by several factors, including

a. The small camera sensor on the DJI Phantom 3 Advanced drone measuring 1/2.3 inch, the larger the camera sensor, the more light information that can be received by the camera so that the quality of the existing image data can be improved and in the midstream area it is possible to be processed.

b. At the other hand using sonar, it found that the deepest river depth was -6 meters and, in the riverbed, found sedimentation, this sedimentation allows light not to penetrate the riverbed and weaken the strength of the light present in the river.

Based on photogrammetry results using the Menci APS application through the Digital Terrain Model (DTM) it was found that the deepest river depth was -49.4 meters, and the lowest was -15.5 meters. The difference in the depth of the river that occurs is caused by several things as, the nature of water that is not homogeneous, not clear and the river is quite deep. The results of the DTM in Figure 4. show that the contours in the undetectable area cannot be described and the deepest river depth is -49.4 meters and the lowest is -15.5 meters. The results of the image in the ArcGis software can be seen in the cross-section A1-A2 there is a difference in height of 1 meter, cross-section B1-B2 there is a difference in height of 0.75 meters, pieces of C1-C2 there are differences in height of 0.5 meters, pieces D1-D2 there are differences in height of 2 meters, E1-E2 pieces have a height difference of 0.75m, and F1-F2 pieces have a height difference of 1.5 meters.

In addition to the manual settings of the drone camera, Sun Radiation and ultraviolet (UV) read by the Weather Station influence producing a display of the resulting photo quality. The effects arising from ultraviolet on photography is to cause images that are not sharp and the emergence of Atmospheric Haze or the number of dust and smoke particles in dry water content makes the photo as if will get foggy [18].
4. Conclusions
1. The outcomes show that the implementation of photography as media and support in construction era 4.0 at civil engineering for the construction design to face tidal floods due to global warming can produce situation nearshore bathymetry map. It can support measurement data for civil works construction for Rob floods problem. Along with, it can help improve the quality of an engineer, because of the self-development has been done. Thus, the results obtained can be used as a reference for inter-community planning.
2. The use of drones, photography, MenciAPS software and ArcGIS are still under investigation because using sonar the deepest river depth was -6 meters and using photography for photogrammetry it was found that the deepest river depth was -49.4 meters.
3. Regarding the results from using DJI Phantom 3 Advanced, it found that the camera sensor is too small that caused data were reading not accurate in MenciAPS software, moreover because the distance of the photos taken was quite far, including 80 meters. It is needed to conduct further research on this method with the use of better and capable tools and understanding.
4. The advantage of this research is that it can be done in a remote area and this method is quite new in Indonesia, in most of the previous studies of this method was found in Europe.

Figure 3. River contour and cross section map in Tegalsari universal transverse mercator (UTM 49 S).
References

[1] Radford T 2019 Melting polar ice sheets will alter weather Retrieved on July 23, 2019 from: https://climatennwnetwork.net/melting-polar-ice-sheets-will-alter-weather/

[2] Prayoga N 2016 Permukaan Air Laut Terus Naik, Bagaimana Nasib Wilayah Pesisir Perkotaan di Indonesia? Retrieved on July 03, 2019 from: https://www.kompasiana.com/nyomanprayoga/569f5dadff97a61640755068d/ permukaanair-laut-terus-naik-bagaimana-nasib-wilayah-pesisir-perkotaan-di-indonesia

[3] Ismail M 2017 Diterjang Banjir Rob, Desa Kupang Malam Ini Waspada Retrieved on June 29, 2019 from: http://im.beritajatim.com/peristiwa/315340/diterjang_banjir_rob,_desa_kupang_malam_in_waspada.html,

[4] Hartanto A and Purnomo Y C2018 Analisis dan Aplikasi Ilmu Teknik Sipil Dalam Adaptsi Perubahan Iklim Global Di Kawasan Pesisir Pantai Sidoarjo Provinsi Jawa Timur (Surabaya: Universitas Kristen Petra) pp 4

[5] Republic of Indonesia Law Number 11 of 2014 Concerning Engineering

[6] Wang S, Baum A, Zarco-Tejada P J, Dam-Hansen C, Thorseth A, Bauer-Gottwein P, Bandini Fand Garcia M 2019 Unmanned Aerial System Multispectral Mapping for Low and Variable Solar Irradiance Conditions: Potential of Tensor Decomposition, J. of Photogrammetry and Remote Sensing 155 58

[7] Kompasiana 2019 Pengertian Fotografer dan Fotografi Retrieved on June 15, 2019 from: https://www.kompasiana.com/Jojokar/5bf79fc843322f1b1b3d4798/pengertian-fotografer-dan-fotografi,

[8] Ritzenthaler M L and Vogt-O’Connor D 2006 Photographs Archival Care and Management (Chicago: The Society of American Archivists) pp 8

[9] Belajar Fotografi 2012 Mengenal Arah Cahaya Retrieved on June 28, 2019 from: http://belfot.com/arah-cahaya/

[10] Cooke A 2015 The Exposure Triangle: Understanding How Aperture, Shutter Speed, and ISO Work Together Retrieved on June 28, 2019 from: https://fstoppers.com/education/exposuretriangleunderstanding-how-aperture-shutter-speed-and-iso-work-together-72878

[11] Crisp S 2013 Camera Sensor Size: Why Does It Matter And Exactly How Big Are They? Retrieved on July 08, 2019 from: https://newatlas.com/camera-sensor-size-guide/26684/

[12] Indarto N D K 2008 Fotografi Konstruksi Retrieved on June 17, 2019 from: https://constphoto.wordpress.com/category/construction-photography/,

[13] Collins Dictionary 2019 Aerial Photography Retrieved on June 17, 2019 from: https://www.collinsdictionary.com/dictionary/english/aerial-photography,

[14] Merriam-Webster 2019 Photogrammetry Retrieved on June 25, 2019 from: https://www.merriam-webster.com/dictionary/photogrammetry,

[15] Fisk E R 1997 Construction Project AdministrationFifth Edition (New Jersey: Simon & Schuster/A Viacom Company) pp 91,96,97

[16] Technopedia 2019 Definition of Geotagging Retrieved on June 25, 2019 from: https://www.technopedia.com/definition/86/geotagging,

[17] Article I Dronetekno69 2019 DJI Phantom 3 Advanced: Review, spesifikasi, harga Retrieved on July 05, 2019 from: https://drone.tekno69.com/dji-phantom-3-advanced/,

[18] Tjonggari D 2019 Mengenal Lebih Jauh Tentang Filter UV retrieved on July 07, 2019 from: https://www.sentradigital.com/mengenal-lebih-jauh-tentang-filter-uv_informasi,

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