Sustainable Design for Passage Boat Ports in Remote Areas in Era Construction 4.0 at Sidoarjo East Java Indonesia

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S Hermawan, K Harsono and N Bong

Civil Engineering Department, Petra Christian University, Surabaya 60236 - Indonesia
Corresponding author: shermawan@petra.ac.id

Abstract. Humans activities can not separate from transportation. In the remote area, one of the favourite types of conventional water transportation was Passage Boat. However, this transportation less pays attention to the safety factor and the facility. The research location in Jabon Subdistrict, Sidoarjo, where many people identified falling into the river in 2019. To reduce the number of accidents, it requires to design and hydrodynamic data at the location. However, the data are too expensive. The goal of this research is to utilise economic devices measurement based on the industrial revolution 4.0 with hydrodynamic methods models in the field of civil engineering and to make a sustainable design for passage boat ports. The methodology in this research initially does measurement nearshore bathymetry data. Then, the numerical hydrodynamic model is carried out for an approach to estimate the hydrodynamics of coastal waters, including tides, currents and water levels using the open-source Delft3D software. The outcomes of this study prove that hydrodynamic modelling can use to determine the height of the water level at maximum tides and low tides and to determine the current velocity to create a suitable passage boat ports design that is safe for the community and environmentally friendly.
Keywords: industrial revolution 4.0, hydrodynamic model, passage boat ports

1. Introduction

Recently every day, human activities will continue to move from one place to a place to work, study or do a hobby. Transportation exists to help the process of moving passengers and goods from one place to another [1]. The research location on the Porong River located in Tegalsari Hamlet, Jabon District, Sidoarjo. There was traditional transportation called a passage boat. Its location is in a remote and strategic area to connect residents of various backgrounds and ages.

Passage boat is traditional water transportation used in the area and villages near the river [2]. Figure 1 shows this passage boat quite well known in the surrounding community because it is enough to pay 3000 rupiahs for a single trip. It can cut travel time rather than overland as well as can transport the community along with their motorbike or bicycle at the same time. But all of these positive values are unfortunately not matched by proper dock conditions. Figure 2 shows the condition of the ports which is fragile, slippery. There is no grip around, and it is not flexible and only has a minimal impression that the community must be more careful when crossing the port.

Figure 1. Passage boat on Porong's river.

Figure 2. Passage boat ports on Porong's river.

There have been several accidents that have occurred, such as many slipping while crossing the port. As a civil engineer see transportation engineering as the utilisation of technology and scientific rules to the planning, functional design, operation and management of facilities for any mode of transportation to provide safe, efficient, fast, comfortable, convenient, economic, and environmentally compatible movement of people and goods [3]. So, the goal of this research is to utilise economic devices measurement based on the industrial revolution 4.0 with hydrodynamic methods models in the field of civil engineering and to make a sustainable design for passage boat ports.

2. Data retrieval and hydrodynamic model setup

The industrial revolution entered the 4th generation. In the 4th generation which conceptualises Cyber-Physical Systems, the Internet of Things and Internet Service will make it easier for humans to get data and information easily [4]. Technological developments in the industrial revolution era 4.0 have produced many tools and software such as drones, deeper smart sonar, and software such as Delft3D, where these tools can not only be used for fun but can also use in data retrieval and data processing in the world Civil Engineering.

2.1. Simulation of Numerical Hydrodynamics Model with Delft3D Open Source

Delft3D-FLOW is a multi-dimensional (2D or 3D) hydrodynamic (and transport) simulation program which calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a rectilinear or a curvilinear, boundary fitted grid. In 3D simulations, the vertical grid defined following the co-ordinated approach [5]. The modelling created can be used to find out what has happened and what will happen in the future because the results of this modelling approach the actual conditions in the field. The selection of software used concerning the speed of the computer used. The unstructured models found to be the most computationally efficient models run on a single core is Delft3D was the most efficient [6].

2.2 Primary Data Retrieval

Primary data collected by direct measurements in the field. Using the Deeper smart sonar pro + tool developed by Deeper company, it uses a frequency of 290 kHz to get the highest bathymetry accuracy with a maximum measuring depth of up to 80 meters [7].

This method refers to the method that is carried out by [8] who uses sonar hanging from a drone, by the method of binding deeper smart sonar with a string and let the ship go 5km / hour slowly (see figure 4) to get an accurate realtime reading through a smartphone application. During measure the nearshore bathymetry data, it is a need to upload process (see figure 4) and can be downloaded in the form of a .csv file which is the XY coordinate and the depth z.

Figure 3. The Deployment of the Deeper Smart Sonar.

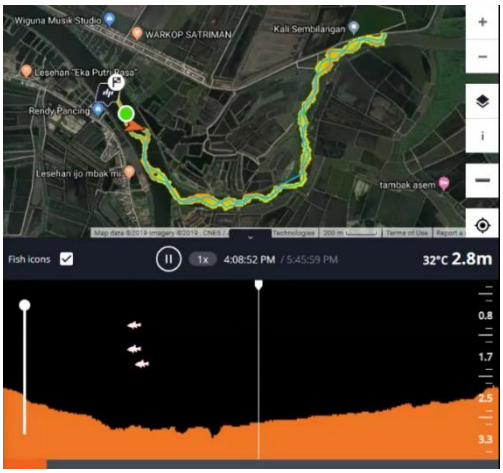

Figure 4. Output Deeper Smart Sonar.

Then, the data is processed using an open-source application called Delft3D. The model set up by creating a rectangular cartesian grid of about 450 meters with 249,804 grids and Manning Roughness 0.05 as in Figure 5. As can be seen at Figure 6, then make a depth sea level with samples from smart sonar and the General Bathymetric Chart of the Oceans (GEBCO) [9] and simulate a vulnerable period of 2 weeks from December 23th, 2018 to January 6, 2019.

Figure 5. Grid untuk Daerah Perairan.

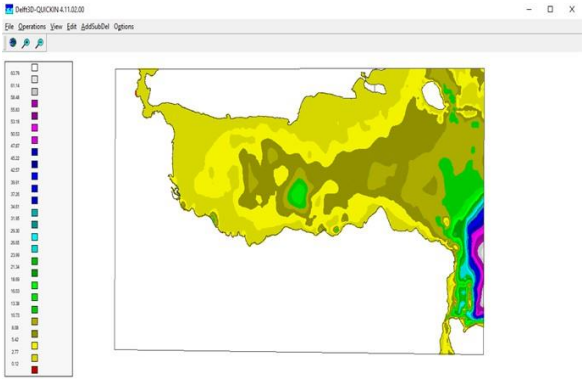

Figure 6. Depth Sea Level.

3. Results and discussion

The development of the industrial revolution 4.0 makes measuring data in the field faster and easier with the help of tools, including sonar. Nearshore bathymetry data from the measurement results are processed with Delft3D software to determine the water level and the current velocity of water that has occurred and will occur. The simulation results in the Porong River obtained several results. As can be seen in Figure 8, the grid used is an average size of 450 m with a total grid of 249,804. The highest tidal point occurred on January 2, 2018, as high as 2 meters and the lowest point is -1.8 meters. From Figure 8, the grid used is an average size of 100 m with a total of 13,416 grids and it is found that the average fast tide current in the west for 2 weeks is relatively weak at around 1.5 meters/second.

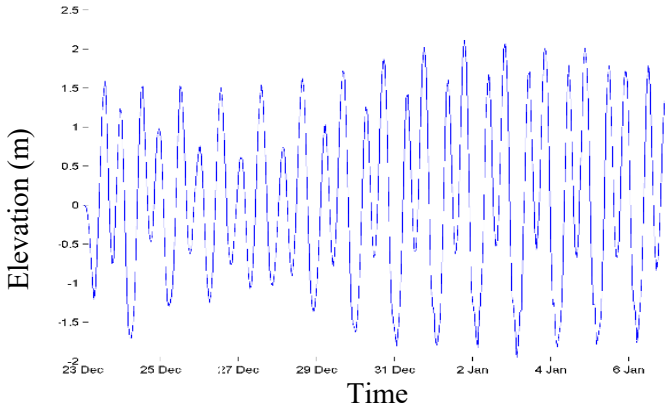

Figure 7. Result of the Water Level Simulation.

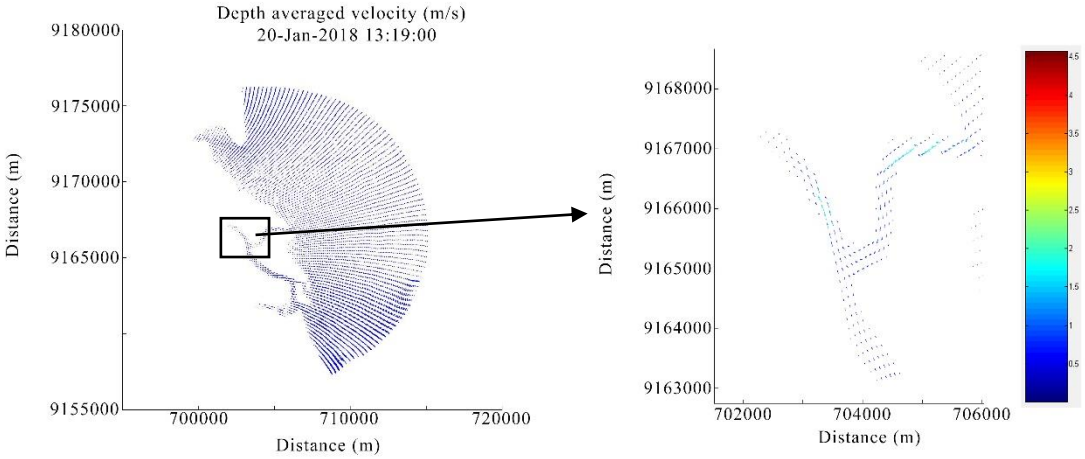

Figure 8. Result of the Depth Average Velocity.

As can be seen in Figure 9, from the outcomes of the numerical hydrodynamic model, the port design made using sustainable materials. The goal of sustainable structural design in the production of a structural system meets the needs of the owner and user while minimising the environmental impact and conserving resources where possible [10]. It can be said as a sustainable material if materials obtained from nature such as wood and bamboo, materials that can be recycled such as aluminium, copper and other metal materials [11]. Like stainless steel used for handrails and stiffeners have high resistance to stress corrosion resistance for use in seawater [12], for pontoon material using a 4 mm thick steel plate formed in a 95 cm diameter tube and filled with cork, has a buoyancy force of 2,743,896.59 gs [13], using webbing bamboo to reduce the risk of people slipping and with this design can follow the water level when the tides are maximum because the pontoon can adjust by itself.

Figure 9. Sustainable Design for Passage Boat Ports.

4. Conclusion

1. Before in the era of the industrial revolution 4.0, the measurement devices for generating hydrodynamic simulation was expensive and took time; however, this research proves that the new device such as sonar can run faster and more accurate for primary data retrieval.
2. The new design of the port for passage boat in Jabon village to be safer, more comfortable and flexible in all conditions during high and low tide without overruling the selection of materials that do not pollute the environment and sustainable.
3. The use of Delft3D software for modelling can employ for another research project because the outcomes are close to the actual conditions in the field.

5. References

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