I.INTRODUCTION

Driven by wind and shaped by elements like the Earth's rotation, seabed geology, and atmospheric pressure systems, waves are essential events in water [1]. Higher waves se- riously endanger boats, causing mishaps and disturbance of operations [2].Nowadays, due to climate change and changes in weather patterns cause high waves in water areas, especially in tropical and subtropical areas, are very common. This condition increases the risk for ships that sail in the waters. The solution to this problem is wave height forecasting, which aims at reducing risks and ensuring safety and efficiency of operational needs. Wave height forecasting with high precision is not only a technological challenge but also a matter of life safety in water areas [3].

Statistical techniques and numerical models are now com- monly used to predict wave height. Although effective, older approaches have limitations such as high processing costs and the requirement for large amounts of time series data [5]. Furthermore, they may be unable to accurately depict wave dynamics' complex and nonlinear nature [4]. Ma- chine learning algorithms have shown considerable promise in predicting wave height. Machine learning models can handle ample information and recognise patterns that older approaches cannot [6]. Wave height forecasting has used Long-Short-Term Memory (LSTM) networks and Support Vector Machines (SVM) with varying degrees of success [2], [7]. These models fail to capture linkages over long periods, especially in complicated data fields such as coastal areas. Particularly in the time series analysis framework, temporal convolutional networks (TCN) are applied in this work to solve the inadequacies of present machine learning models in wave height forecasting. Aimed for sequential data pro- cessing, the TCN detects long-range associations [8] better than conventional RNN-based models. This work employs temporal convolutional networks (TCN) to address the diffi- culty of wave height forecasting at sites with notable wave activity.

In this study, we investigated wave condition is the coastal region in Pacitan Bay, East Java, Indonesia, that dominantly consisting of swell generated in the Indian Ocean [9]. Pacitan Bay has an important role as it serves as a route or stopover for coal-carrying barges, especially when facing bad weather conditions or high waves. Accurate wave data in Pacitan's coastal area is obtained using nested high-density wave simulations with the SWAN model [10]–[12]. This work uses a range of scenarios and training data periods to investigate, across 3, 7, 14, and 21-day intervals, how well the TCN forecasts results. Random search methods of hyperparameter tuning assist the TCN model to be optimum. Using estab-lished machine learning models—more notably, CNN and Transformer models—time series forecasting enables one to evaluate the TCN performance. Two methods of evaluation for the model are Coefficient of Determination (R^2) and Root Mean Square Error (RMSE).

The structure of this paper is as follows. Section II presents a literature review on wave height forecasting, temporal con- volutional networks (TCN), convolutional neural networks (CNN), and Transformer methodologies. Section III outlines the methods utilised. Section IV presents the forecasting results obtained from TCN, CNN, and Transformer method- ologies. The conclusion of the paper is given in Section V.