Blue economy policy model for encouraging regional growth in South Sulawesi

[1]Muhammad Yusuf, [2]Andi Samsir, [3]Siswan Tiro, [4]Muhammad Ilyas, [1]Andi D. Riana, [5]Amran Saru, [6]Mubariq Ahmad, [6]Christy D. Pratama

[1] Department of Agrobusiness, Faculty of Fisheries, Cokroaminoto University, Makassar, South Sulawesi, Indonesia; [2] Department of Economics Development, Faculty of Economy and Businness, State University of Makassar, Makassar, South Sulawesi, Indonesia; [3] Perkumpulan Katalis Indonesia, Makassar, South Sulawesi, Indonesia; [4] Marine Affairs and Fisheries Department of South Sulawesi Province, Makassar, South Sulawesi, Indonesia; [5] Department of Integrated Coastal Resources Management, Post Graduate School, Hasanuddin University, Makassar, South Sulawesi, Indonesia; [6] Conservation Strategy Fund, Graha Simatupang, Jakarta Selatan, Indonesia. Corresponding author: M. Yusuf, yusufhalim2014@gmail.com

Abstract. Indonesia has a high potential for marine and fisheries resources. However, they have not become the central pillar of national development, and their contribution is low, compared to any other sector. Thus, a development model is needed to encourage the growth of marine and fisheries resource-based sectors as a pillar of national development. The blue economy model can be implemented in the national development, and, as a business model, it prioritizes innovation, job creation, community welfare improvement, and environmental conservation. The present study aimed to develop policy scenarios based on blue economy for encouraging regional economic growth in South Sulawesi. The study implemented a quantitative approach by using dynamic system analysis techniques. The study was conducted in marine resources-based cities and districts in South Sulawesi, including Makassar, Maros, Pangkep, Barru, Pare-Pare, Pinrang, Takalar, Jeneponto, Bantaeng, Bulukumba, Selayar, Sinjai, Bone, Wajo, and Luwu. The data collection involved primary and secondary data. The data collection methods were: desk study, FGD (focus group discussion), survey (interview), and field observation techniques. The results of blue economic policy model in South Sulawesi can be supported through the output of the electricity sector, which leads to an increase in the output of the fisheries sector (fishery value) by USD 105,626 or around 12.29%. Increasing the output of the fisheries sector will lead to regional economic growth through the fisheries industry (ice factories, cold storage, etc.), and the food and snack industry, using fish or seafood as inputs. This industrial growth will absord labor, open up new business opportunities, and increase community and regional income. Thus, the blue economic model can become one of the pivotal policies of the South Sulawesi governement for driving the regional economic growth.
Key Words: fisheries, marine resources, scenario, GDP, fish stocks.

Introduction. Indonesia's natural resources have great potential for developing fisheries and marine sectors (Nurkholis et al 2016). The enormous potential resources in both sectors are considered the principal capital in regional and national development (Firdaus & Rahardian 2018). The marine resources have a broaderexploitation potential than land, due to a rich diversity (Gani et al 2022). Moreover, almost 60% of Indonesia's population lives in coastal areas and islands with various livelihoods, including fishermen. Even though some sectors like fisheries, transportation, and mining have been developed in marine and coastal areas, they still face technological limitations (Kunarso 2011). The government's efforts in developing Indonesian fisheries and maritime affairs are outlined in a vision of the sea as the nation's future, focused on three development pillars: sovereignty, sustainability, and prosperity (Pudjiastuti 2017). Coastal and marine development policies are essentially related to poverty-handling programs since most of these are rural, remote, and underdeveloped areas (Samsir 2015). On the other hand, the development of the fisheries sector must be carried out optimally and sustainably, starting from the upstream, namely with fishing (Hermawan et al 2021a,2021b; Yulinda et al 2020; Hutajulu et al 2019a,2019b; El Fajri et al 2021), but also including the portuary infrastructure (Danial et al 2020), the aquaculture (Eddiwan et al 2021), and and the social framework (Hasbi et al 2022).

South Sulawesi Province is one of the regions in Indonesia that has extensive coastal and marine areas. The areas cover Makassar Strait, Flores Sea, and Bone Bay, as well as small islands in the Spermonde and Takabonerete areas, with a coastline of around 1,980 km and seawater area of around ±48,000 km^2 (Mosriula 2018). Based on data from the Central Bureau of Statistics (BPS), the production of the marine capture fisheries sub-sector in South Sulawesi is relatively large, but its growth is in a stagnant stage. From 2018 to 2020, the average production was 353.94 tons per year, with a contribution of only 5.22% to the national production. Thus, the sector is often marginalized compared to other national development sectors.

The Ministry of National Development Planning (Bappenas) created The Indonesian Blue Economy Development framework for Indonesia's economic transformation, including the marine sector asa pillar, which is reflected in the National Long-Term Development Plan (RPJPN) 2005–2025, for a strong, sovereign, and developed country. Furthermore, the framework also aims to emphasize the importance of good marine management to achieve the sustainable development program and to support global initiatives in reaching the 2030 sustainability development goals points 7, 8, 9, 14, and 17. The blue economy development must be seen as an integrated framework for marine/ocean resources-based sectors. Philippines offer a model of the marine resources focusing on the challenges and policy opportunities in the marine sector (Mendoza & Valenzuela 2017). Likewise, Seychelles in Eastern Africa, an island country, implements the Blue Economy Development by mapping a new development path (Senaratne 2020). In Thailand, the Blue Economy Development is utilized as a tool or approach to direct the future of Thailand based on the past and present (Koondee et al 2022). In Nigeria, the Blue Economy Development approach aims to achieve the goals of the maritime sector (Igbozurike 2020). Furthermore, in Indonesia, several studies have been conducted, such as the economic impact on developing capture fisheries (Kusdiantoro et al 2019), the Blue Economy Development implementation for fisheries sustainability (Misuari et al 2015), the alternative policies based on blue economy for the skipjack (*Katsuwonus pelamis*) fishery management of Jayapura City, Papua, Indonesia (Hutajulu et al 2021), the development of the blue economy based on economic activities (Adriadi et al 2022), and the potentials and challenges of the Blue Economy Development in supporting economic growth (Nasution 2022).

The 2022 United Nations Ocean Conference in Lisbon considers that strengthening a sustainable ocean-based economy and managing coastal ecosystems are essential for the country's development. It is based on the world's coastal population, which contributes significantly to the global economy, around 1.5 trillion USD per year, and is expected to reach 3.0 trillion USD in 2030 (Šabić & Vujadinović 2017). The Blue Economy Development is essential for small islands developing states (SIDS), including Indonesia, by ensuring a healthy marine ecosystem, the availability of livelihoods, anda targeted economic growth in vital sectors, such as fisheries and aquaculture, tourism, energy, shipping and port activities, seabed mining, renewable energy, and marine biotechnology.

The blue economy development regards marine resources as an essential asset since it provides food security, nutrition, employment, foreign exchange, and tourism. It is in line with the World Bank (2017), which defines the blue economy as environmentally-based marine resource utilization to support economic growth, prosperity, livelihoods, and marine ecosystem preservation. Furthermore, the blue economy development prioritizes the three pillars of sustainable development: environmental, economic, and social. It aims to create job opportunities, uplift the community welfare fairly, and maintain the support and quality of the environment (Spalding 2016). The blue economy can also integrate sustainable land- and sea-based socio-economic development to achieve ecological, economic, and social goals (Kathijotes 2013). It also implies a new development by prioritizing sustainability, resource preservation, and survival of the earth. The blue economy development implementation is vital since the fisheries management main issue is the low contribution to economic growth, both regional and national levels. Thus, the present study aimed to develop policy scenarios based on blue economy for encouraging regional economic growth in South Sulawesi.

Material and Method

Description of the study sites. The study was conducted in marine resources-based cities and districts in South Sulawesi, including Makassar, Maros, Pangkep, Barru, Pare-Pare, Pinrang, Takalar, Jeneponto, Bantaeng, Bulukumba, Selayar, Sinjai, Bone, Wajo, and Luwu. Fifteen cities and districts were selected based on marine resource available in their areas. These fifteen cities and districts have more maritime GDP than the GDP of other sectors. There were six cities and districts in the Makassar Strait, including five cities/districts in the Flores Sea and four cities/districts in the Bone Bay*.* The criteria were chosen considering the aim of the study was the blue economic sector. World Bank (2017) defines the blue economy as the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem. A blue economy generates economic and social benefits while ensuring oceans' long-term environmental sustainability.

Types and sources of data. The data collection involved primary and secondary data. Primary data was obtained from the field or from respondents, including data on the utilization of marine resources and the relationship with other sectors. According to Yusuf et al (2020), primary data are obtained through the field of study or from respondents. Primary data were obtained through focus group discussions and interviews with stakeholders involving the Marine Affairs and Fisheries Department, Central Bureau of Statistics, Industry Department, Mining (Offshore) Department, Maritime Transportation Department, Regional Revenue Department, Trade Department, Hoteliers Association, Tourism Entrepreneurs Association, and Logistics Entrepreneurs Association. Besides, field visits were done in 4 areas, related to economic objectives including: Phinisi Boat makers in Bulukumba, loading and unloading infrastructure at Soekarno Hatta Port in Makassar, transportation for crossing the river in Gowa, and littoral tourism facilities in Barru and Pare-pare. Meanwhile, the secondary data was obtained through literature, including the Provincial level of Gross Domestic Product (GDP), the Regency or city level of GDP per sector (52 sectors), and the national maritime GDP, for 12 clusters.

Method of collecting data. The data collection methods were: desk study, FGD (focus group discussion), survey (interview), and field observation techniques. Yusuf et al (2021) stated that these techniques of data collection are generally applied in research. The desk study was intended to obtain secondary data from related government departments, such as the Central Bureau of Statistics, Fisheries Department, Energy and Mineral Resources Department, Sea Transportation Department, Tourism Department, and South Sulawesi Regional Revenue and Regional Planning Development Department. Secondary data collected through desk study include: 1) economic activities at sea (shipping or sea transportation, fisheries, offshore oil and gas, mining at sea, construction at sea, and sea tourism/diving), 2) economic activities near to the sea, on the coast, beaches, and island (cultivated fisheries, ports, mining on coast, oil and gas refineries, electricity, sea water refineires, ice factories, warehousing, beach, coastal, and sea toursim, 3) economic sectors on land that depend on natural input from the sea, both biotic and abiotic (food industry, chemical and pharmaceutical industry, restaurants, and fish processing industry), 4) economic activities on land which provide goods or services to areas at sea, coast, beaches and/or islands (shipbuilding industry, machinery industry, ship rope industry, fresh water supply, educational services, building materials such as sirtu, etc.), and 5) economic activities located or near to rivers and/or lake (river and lake transportation, fishing activities in rivers and lakes, hydropower, river and lake tourism). The secondary data were obtained through various departments or agencies, including the Central Bureau of Statistics, Marine Affairs and Fisheries Department, Energy and Mineral Resources Department, Sea Transportation Department, Tourism Department, South Sulawesi Regional Revenue and Regional Planning Development Department.

The data obtained through FGD were required for relating the concepts and definitions related to blue economic sectors based on Maritime GDP (2017-2021), which consists of 12 Clusters 373 KBLI, and regional GDP involving 23 industries, including; 1) Fisheries, 2) Oil, Gas and Geothermal Mining at sea or coast, 3) Metal Ore Mining at sea and coast, 4) Mining and Other Excavations at sea and coast, 5) Coal Industry and Oil and Gas Refining (offshore), 6) Food and Beverage Industry made from fish/seafood, 7) Chemical Industry made from sea raw materials, 8) Pharmacy and Traditional Medicine made from sea raw materials 9) Marine Goods Industry, 10) Machinery and Equipment Industry for ships, 11) Sea Transportation Equipment Industry, 12) Fisheries Processing Industry, 13) Repair and Installation Services for Ship Machinery and Equipment, 14) Water-based electricity, 15) Water Supply, 16) Construction at sea, coast or beach, 17) Sea Transportation, 18) Lake River and Ferry Transport, 19) Harbor warehousing, 20) hotels, resorts and cottages, 21) marine related education services, 22) Maritime security land and 23) Tourism services. Meanwhile, the survey technique was utilized by interviewing the respondents to obtain data on activities resulting from marine resources exploitation. The interview is one of the most used instruments to obtain primary data (Creswell 2014). Data collected through interviews include the amount of capture fishery production, type and amount of aquaculture production, type and price of fish, type and number of fishery industry businesses including ice factories and cold storage, number of fishermen, type and number of fish-based food and beverage industry businesses (seafood), number loading and unloading of ships per year, total oil and gas mining production at sea, number of boats produced per year, total electricity production based on water resources, number of hotels and fixed season occupants, types of sea and beach tourism and total costs for tourism. Interviews were conducted with 47 direct actors, including ten fishermen, ten fish cultivators, two marine mining entrepreneurs, two sea transportation entrepreneurs, two fisheries industry entrepreneurs, two fish or seafood raw material industry entrepreneurs, two river and lake transportation entrepreneurs, two logistics entrepreneurs, one National Electricity Company/PLN (power plant) officer, two hoteliers, two tourism officers, and ten tourists. Further, the observation technique aimed to obtain primary data through observing marine resources of the community and related sectors. Data obtained through field observation were phinisi boat maker activities, loading and unloading flow at the port, river crossing and transportation activitiesin Gowa, and beach tourism activities in Barru. These data were collected through documentation and they were further analyzed comprehensively.

Data analysis method. The data were analyzed by applying the dynamic system analysis method. The dynamic system analysis is basically based on causality (cause-and-effect) in constructing a complex system model to recognize and understand the dynamic behavior of the system. In other words, the analysis is more focused on increasing the system patterns and regular behavior that emerge from the structure. Sterman (1984) stated that the main hypothesis of a dynamic system is the persistent dynamic tendencies of any complex behavior arising from its causal structure. Muhammadi et al (2001) stated that a dynamic system is a comprehensive, dynamic, and integrated system approach that simplifies complex issues without eliminating the main elements of concern. It is further stated that dynamic systems can describe complex and dynamic actual conditions in a simpler form by examining the behavior of the components in the system. According to Sterman (2000), two essential things must be considered in developing a dynamic system model. First, the model represents actual conditions; second, the model must be specific to solve certain issues. Furthermore, there are two dynamic system characteristics. They are causality and feedback between variables. The model construction in the study was the relationship model between macro and micro variables, in which the relationship between sectors shows a multiplier effect. The model construction is illustrated in Figure 1. Figure 2 represents a stock-flow diagram based on the causal loop diagram.

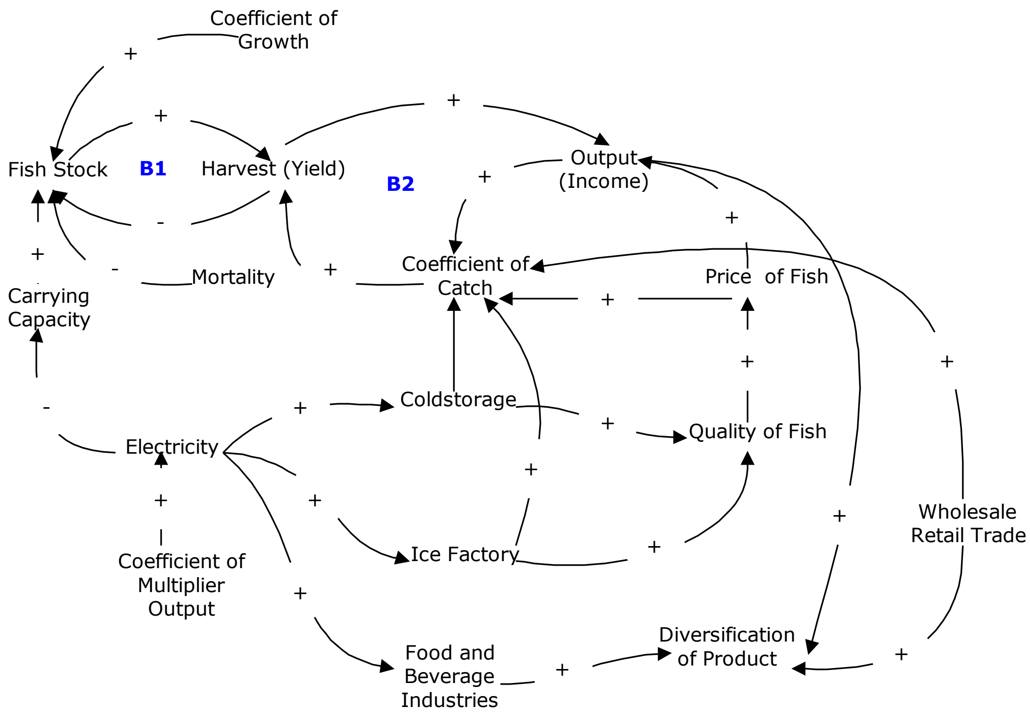

Figure 1. Causal Loop Diagram (CLD) model of South Sulawesi blue economy policy.

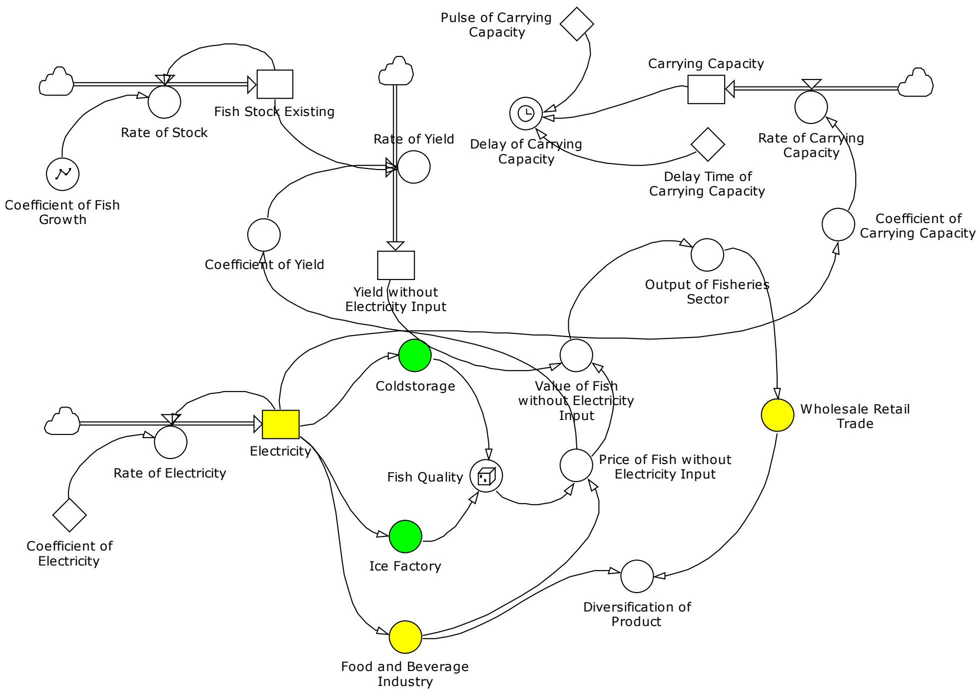

Figure 2. Stock Flow Diagram (SFD) model of South Sulawesi blue economy policy.

The Causal Loop Diagram (CLD) model, as shown above, was formed based on previous research results (Yusuf et al 2023), in which the electricity sector had the highest output multiplier value, around 2.8822. It is in line with the fact that the energy supply in South Sulawesi experienced a surplus of 560 megawatts, with an electrification ratio reaching 99.80%. This multiplier value will encourage growth in other sectors, especially in the fisheries sector, through increasing the construction of cold storage, ice factories, and food and beverage industries made from fish and/or seafood. Industrial development will improve fish quality and product diversification, thereby increasing wholesale and retail trade and the output of the blue economy sector.

Furthermore, data and equations (syntax) were input into the model, and then the model was run. The results of the model were then tested for validity. Tests need to be done to ensure the model's level of validity. Model validation involves structure and output validation. Structure validation was done by testing each structure formed to examine its accordance or discordance with the theory. Hartisari (2007) stated that structure validation is done by checking the model structure consistency with the descriptive knowledge system involved in the process of the model being constructed. Meanwhile, output validation aims to ensure that the extent of model output is compatible with the actual output; thus, it can meet the requirements of a scientific model based on facts. Various model behavior tests can validate the developed model. According to Tasrif (2007), model testing must be done by the recommended statistical method. Visual and statistical validation has also been utilized by Hartisari (2007) through the development of a dynamics system. Sterman (2000) stated that a robust model requires a particular variety of tests to uplift the user's trust in the model's ability to represent the system. Trust becomes the basis for the model's validity. If the model's validity has been achieved, the further stage can be used to construct effective policies. One of the commonly used validation methods for measuring error level is Mean Absolute Percent Error (MAPE) or the absolute error percentage of the average (Sterman 2000). Furthermore, de Myttenaere et al (2016) stated that MAPE measures accuracy forecasting methods to determine the percentage deviation of estimation results. The MAPE is useful when the hypothesis variable is quite significant (Chai & Draxler 2014). Moreover, Tuck & McKenzie (2015) stated that MAPE intends to measure the accuracy of forecasting by comparing the output analysis and the database (existing value). The following is the formula utilized to calculate MAPE:

$$\mathrm{MAPE} = \frac{1}{n}\sum \frac{\mathrm{At} - \mathrm{St}}{\mathrm{At}} * 100$$

Where:
At - the actual value;
St - the forecast value;
n - total number of observations.

If the actual value is equal to the forecast value, then MAPE is zero, meaning very accurate. Thus, the smaller the MAPE value, the more accurate the prediction model developed. In other words, forecasting is close to the actual condition. The decision on the accuracy of the forecast (prediction model) obtained is based on the criteria developed by Khair et al (2017) as follows:

Table 1

Forecast accuracy criteria based on MAPE values

MAPE-values	*Criteria*
MAPE ≤ 10%	Highly accurate forecast
10% < MAPE ≤ 20%	Good forecast
20% < MAPE ≤ 50%	Reasonable forecast
MAPE > 50%	Inaccurate forecast

If the model is valid and can be used as an estimator, then a modeling scenario will be done. The modeling scenario is done with two models. The first one is the existing model simulation, commonly called Business As Usual (BAU) simulation. It is the model simulation without changing the model’s structure and data (built values assumption). The second one is a simulation scenario. It is a simulation that changes the model, both structure and the data that is being constructed, to obtain a better model. The simulationresults then become policy recommendations for the study conducted.

Results and Discussion. Simulation analysis of the Blue Economy policy in South Sulawesi was applied through a dynamic system modeling approach. The model developed in this study was a model related to the main sectors, namely the electricity and fisheries sectors, the link among emerging sectors such as the food and beverage industry sectors, and the wholesale and retail trade sectors. The simulation model was developed through the influence of the output of the electricity sector on the fisheries sector, which has a high impact on the marine resources' potential and is highly developed as a leading sector that not only produces high economic value but also absorbs large amounts of labor and has the effects of a multiplier on input and output. The model above illustrates that the output of the electricity sector has a direct influence on the fisheries sector, particularly on the energy supply for thecold storage, ice factories, and the food industry, fish canning, etc. The existence of cold storage and ice factories will significantly influence the fish quality. Thus, it creates a price stability. The blue economy policy simulation shows that the multiplier effect of the electricity sector can generate growth in other sectors, particularly the sectors that utilize the electricity sector's output, such as the food and beverage industry sector, the fisheries industry sectors (ice factories, and cold storage), and the fisheries processing industry from raw, semi-raw, to processed materials. The existence of high electricity output encourages the sector's growth, including in fisheries. The available energy supply encourages the development of cold storage, ice factories, and food and beverage industries based on fishery raw materials resources (fish and seaweed). The development of the fisheries industry (cold storage, ice factories, and processing industries) also supports the price stability of the fish.

Figure 3 shows that the fish price in the BAU model fluctuates more than in the simulation model. The price stability will significantly influence the value and output of the fisheries sector.

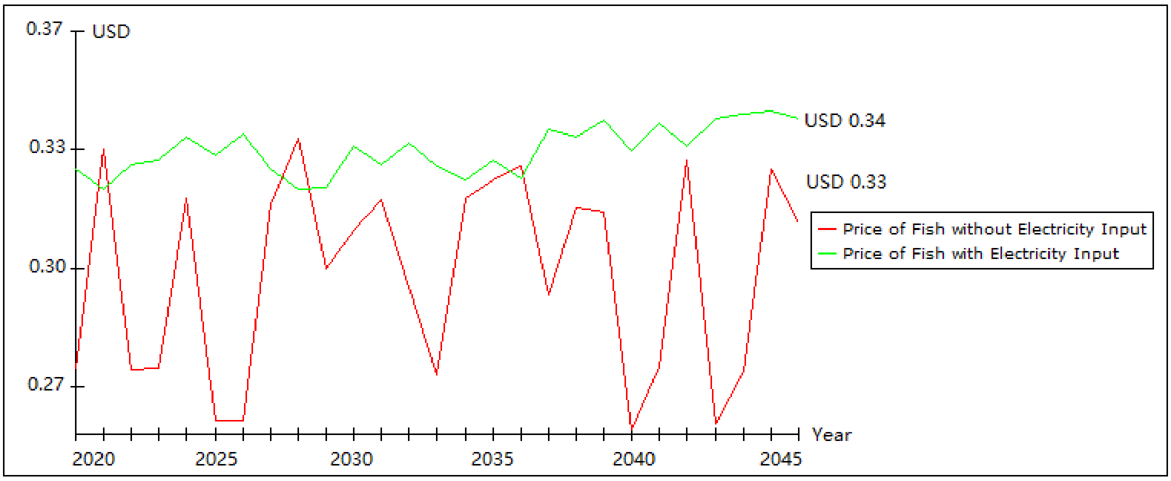

Figure 3. Fish price simulation (primary data).

The price stability in the simulation model with electricity output was due to the available energy supply that supported the fishing industry development, particularly cold storage and ice factories. Both of them will maintain the fish quality. Cold storage will accommodate large quantities of caught fish while maintaining its quality. Mulyaningtyas et al (2020) state that the capacity of cold storage is one of the critical factors in reducing the variance in average fish prices, particularly in the peak season. Cold storage brings a balance between supply and demand. Consequently, it brings the fish price stability. According to Hanafiah & Saefuddin (2006), during peak season, the supply is abundant, and the price decreases drastically. Meanwhile, during the lean season, the supply is lower, and the price is relatively high. The condition can be avoided by using cold storage to maintain the availability of fish supplies throughout the year. Furthermore, the availability of ice facilitates the fishermen and distributors to obtain ice to maintain the quality of fish after being caught until it reaches the consumers.

One of the main factors of the instability of fish prices is the difficulty of maintaining the fish quality. The low-quality fish have relatively low prices, and vice versa. The price fluctuation in the BAU model is very huge, in the interval USD 0.23 to USD 0.33. The change was by USD 0.1 higher than the change in the simulation model, of around USD 0,00013 (in the interval USD 0.32-USD 0.33). The fish price stability will provide high profits for fishermen and consequently it will increase the fisheries' value. It is illustrated in the graphic below (Figure 4).

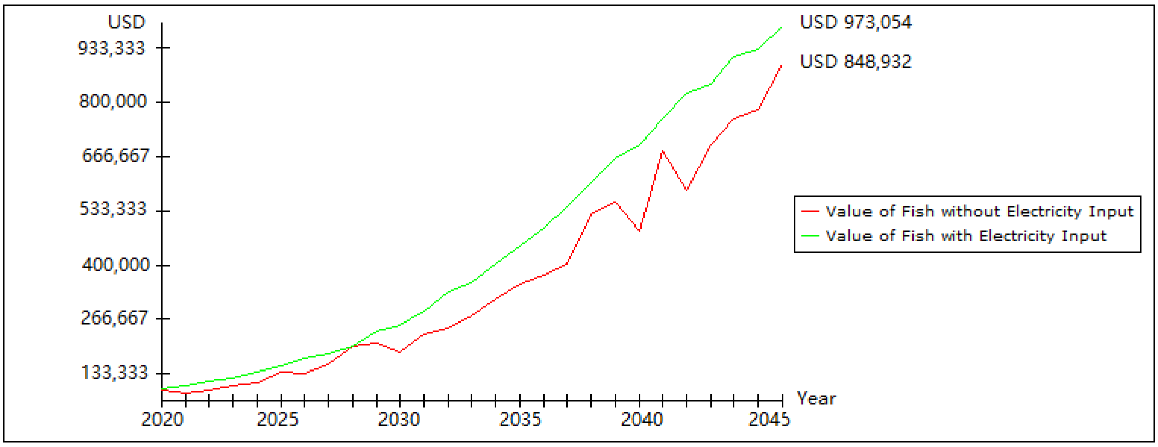

Figure 4. Fish value simulation (primary data).

A stable fish price can provide higher profits. It can be observed in the graphic above that the SIM (simulation) of the fisheries' output value graph is higher than the BAU fisheries' output value. This is due to the fish price stability in SIM. Meanwhile, the fish price is relatively fluctuating or it is less stable in BAU. Good quality fish will have a reasonable selling price, and vice versa. According to Pasaribu et al (2014), the most influential factor on the flying fish (*Decapterus russelli)* price at the Nusantara Brondong Port, Lamongan Regency, is the fish quality. Fish is prone to rapid quality decline. The lower quality of fish will reduce the price. According to Tambani (2008), the fishery products characteristics are seasonal, perishable, and quickly damaged, the changes in stock quantity, and the availability of substitute materials. Thus, factors such as supply, demand, and quality are essential. The stability and high value of the fisheries sector will bring a multiplier effect on other sectors, such as wholesale and retail sectors, related to both domestic and international trading. Furthermore, it also increases the community's income, such as fishermen, the labor absorption in various connected sectors, such as the fisheries industry sector of processing and production (facilities and infrastructure, etc.). However, fisheries' output is also significantly determined by fish resource stocks and catches. It is illustrated in Figure 5.

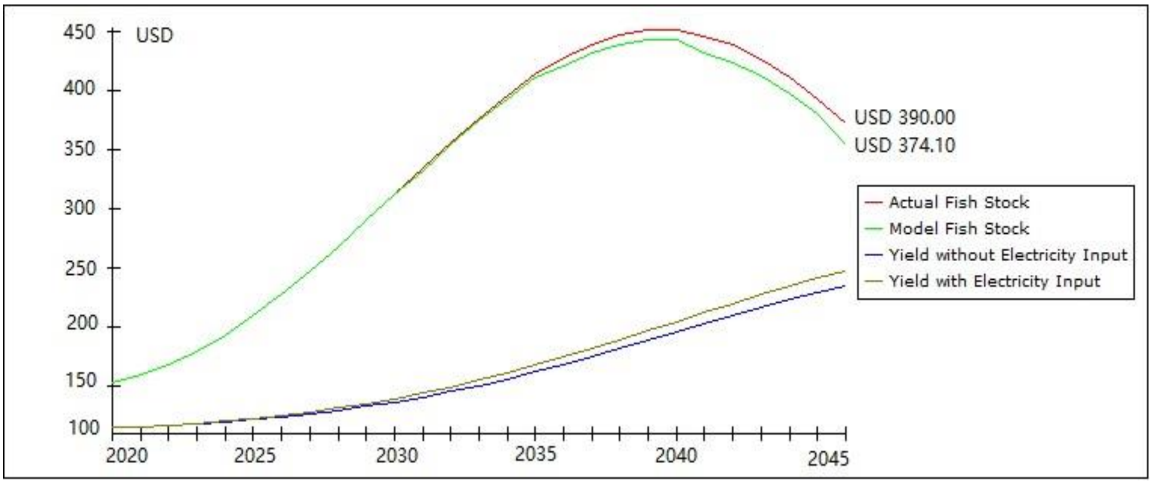

Figure 5. Fish stocks and catches (primary data).

The graph above shows the fish stocks decrease when the fish catches increases. It is due to an increased catch coefficient caused by an increase in output from the electricity sector. It influences the growth and development of the fishing industry, such as cold storage, ice factories, processing industry, and food and beverage industry (fish canning, seaweed industry, food and beverages).

The simulation results of the fishery output value and fish stocks, as the impact of the electricity output multiplier, indicated significant changes (Table 2).

Table 2

Dynamic model simulation results (fishery output values and fish stocks)

Year	*Actual fish stock*	*Model fish stock*	*Fish value without EI*	*Fish value with EI*
2020	1,074,147	1,074,147	84,549	97,975
2021	1,203,045	1,203,045	86,818	106,835
2022	1,371,471	1,371,471	104,422	115,355
2023	1,590,906	1,590,906	107,891	126,428
2024	1,877,269	1,877,269	128,854	135,259
2025	2,205,791	2,205,791	119,839	148,210
2026	2,566,005	2,566,005	151,421	163,006
2027	2,955,029	2,955,029	172,386	187,998
2028	3,368,470	3,368,470	164,612	209,461
2029	3,800,356	3,800,356	205,490	226,579
2030	4,243,165	4,243,165	226,407	267,117
2031	4,687,940	4,647,032	237,116	299,769
2032	5,124,504	5,079,787	304,420	322,209
2033	5,541,785	5,493,427	322,166	361,104
2034	5,928,226	5,876,496	341,688	409,021
2035	6,272,275	6,217,542	311,989	462,670
2036	6,562,927	6,415,704	426,894	495,096
2037	6,790,286	6,637,962	456,633	538,744
2038	6,946,099	6,790,279	427,679	596,638
2039	7,024,242	6,866,670	449,988	645,936
2040	7,021,107	6,863,605	504,349	683,604
2041	6,935,850	6,647,637	667,807	761,655
2042	6,770,505	6,489,162	656,372	814,881
2043	6,529,910	6,258,565	744,466	862,309
2044	6,221,488	5,962,959	713,228	910,341
2045	5,854,865	5,611,571	859,482	965,108

The table above illustrates an increase of the fisheries' output value from USD 859,482 to USD 965,108. It means that there has been an increase of USD 105,626 or around 12.29% of the fisheries ouput value due to the support of the electricity sector. It happened since there was a rise in fish price as a result of an increasing demand. The electricity sector output has supported the increase of cold storage and ice factories, as well as the diversification of fish processing business, including the food and snack industry, made from fish and seafood. Thus, the blue economy policy in South Sulawesi can be supported through the output of the electricty sector to increase regional economic growth. The increase of 12.29% was expected to improve the labor absorption, the business opportunities, the regional economy, and the marine resource-based sector economy. However, the policy requires deep consideration since the rising demand for fish may cause an increase of catches, which leads to the decrease of fish stocks. Although the decrease is not significant, it still requires surveillance, since fish resources are strategic and their sustainability needs to be maintained. Through the support of electricity sector, there has been an increase in the output of fishery sectors that led to a decrease of 243,294 tonnes or around 4.16 % the in fish stock.

Conclusions. The results of the South Sulawesi blue economy sector policy simulation show that the electricity sector output promotes the growth of other sectors, including fisheries, through the existence and increase of cold storage, ice factories, and the processing food beverages industry (fish, seaweed, etc.). The blue economic policy model in South Sulawesi can be supported through the output of the electricity sector, which leads to an increase the output of the fisheries sector (fishery value) by USD 105,626 or around 12.29%. Increasing the output of the fisheries sector will lead to regional economic growth through the fisheries industry (ice factories, cold storage, etc.), and the food and snack industry, using fish or seafood as inputs. This industrial growth will absord labor, open up new business opportunities, and increase community and regional income. Thus, the blue economic model can become one of the pivotal policies of the South Sulawesi governement for driving the growth of regional economic.

Acknowledgements. The authors would like to thank to the Conservation Strategy Fund (CSF) for funding this research, through the GWA IV Grant Agreement No. GA02-CSFIDN-GWAIV-2022, to the South Sulawesi Province Maritime and Fisheries Department, in particular to Mr. Muhammad Ilyas, the Head of the Department, for the full support, and also to our mentors in this study, Mr. Mubariq Ahmad and Cristy Desta Pratama (CSF Indonesia).

Conflict of interest. The authors declare no conflicts of interest.

References

Adriadi G. S., Afifi M., Saripta B. W. M., 2022 [Development of blue economy-based economic activities in the coastal areas of the Mandalika SEZ]. Journal of Konstanta 1(1):1-10. [In Indonesian].

Creswell J. W., 2014 Research design: qualitative, quantitative, and mixed approaches. SAGE, 273 p.

Chai T., Draxler R. R., 2014 Root mean square error (RMSE) or mean absolute error (MAE)? Arguments against avoiding RMSE in the literature. Geoscientific Model Development 7(3):1247-1250.

de Myttenaere D. A., Golden B., Grand B. L., Rossi F., 2016 mean absolute percentage error for regression models. Neurocomputing, Elsevier, 23rd European Symposium on Artificial Neural Networks 192(2):38-48.

Danial, Syahrul, Hamsiah, Ernaningsih, Yusuf M., 2020 Evaluation and development strategy of PPI Beba (Fish Landing Port) in Takalar District, Indonesia. AACL Bioflux 13(5):3037-3045.

El Fajri N., Prianto E., Adriman, Sibagariang R. D., Batubara U. M., Yusuf M., Riana A. D., 2021 Capture fishery management status through the ecosystem approach on fish resources domain in Sungai Apit sub-district, Siak district. AACL Bioflux 14(3):1308-1316.

Eddiwan, Sukendi, Siregar Y. I., Saam Z., Yusuf M., Sabiq M., 2021 Designing management of sustainable shrimp cultivation area in East Lingga, Lingga District. AACL Bioflux 14(3):1317-1325.

Firdaus M., Rahardian R., 2018 [The role of the fisheries sector in the coastal areas of West Kalimantan Borders]. Journal of Sosial Ekonomi Kelautan dan Perikanan, 13(1):15–27. [In Indonesian].

Gani I., Auliansyah A., Gaffar E. U. A., Muliati M., Aprianti Y., Rachmadi R. F. R., Agustina N. I., 2022 Makassar Strait area development in Indonesia based on the marine economy sector. Economies 10(8):1-18.

Hanafiah M., Saefuddin A., 2006 [Fisheries product trading]. Universitas Indonesia Press, Jakarta, 212 p. [In Indonesian].

Hartisari, 2007 [System dynamics: system concepts and modeling for industry and the environment]. Seameo Biotrop, Bogor, 125 p. [In Indonesian].

Hasbi, Armin, Sakaria, Sabiq M., Murni A., Yusuf M., Malik, 2022 Determinants of 'punggawa-sawi' power relations and capital on the socio-economic household of

the fishing community in Paotere Port of Makassar City. AACL Bioflux 15(1):164-173.
Hermawan D., Andriawan S., Yusuf M., Riana A. D., Masriah A., Suryahman A., Sabiq M., 2021a Sustainability and feasibility analysis of the skipjack (*Katsuwonus pelamis*) fishery in Buhung Pitoe Island, Indonesia. AACL Bioflux 14(3):1513-1523
Hermawan D., Andriawan S., Yusuf M., Riana A. D., Alpiani, Sabiq M., 2021b Model of skipjack (*Katsuwonus pelamis*) production based on social and economic aspects in the Buhung Pitue Island, Indonesia. AACL Bioflux 14(4):2436-2446
Hutajulu H., Imran Z., Budiharsono S., Kusumastanto T., 2021 Alternative policies based on blue economy for the skipjack (*Katsuwonus pelamis*) fishery management of Jayapura City, Papua, Indonesia. AACL Bioflux 14(4):2265-2279.
Hutajulu H., Imran Z., Budiharsono S., Kusumastanto T., 2019a Economic structure analysis in the development of skipjack tuna (*Katsuwonus pelamis*) fisheries industry in Jayapura City, Papua, Indonesia. AACL Bioflux 12(5):1726-1737.
Hutajulu H., Imran Z., Budiharsono S., Kusumastanto T., 2019b Economic policy in the development of capture fisheries in Jayapura City. IOP Conference Series: Earth and Environmental Science 241:1-7.
Igbozurike J. K., 2020 Achieving the blue economy dream in the nigerian maritime sector. Social Science Research Network, pp. 1-7.
Kathijotes N., 2013 Keynote: Blue economy - Environmental and behavioural aspects towards sustainable coastal development. Procedia - Social and Behavioral Sciences 101(1):7–13.
Khair U., Fahmi H., Sarudin A. H., Rahim R., 2017 Forecasting error calculation with mean absolute deviation and mean absolute percentage error. Journal of Physics Conference Series 930(1):12-20.
Koondee P., Sharafuddin M. A., Madhavan M., 2022 Blue economy: The past and present from the world and future directions for Thailand. Maritime Technology and Research 4(2):25-32.
Kusdiantoro, Fahrudin A., Wisudo S. H., Juanda B., 2019 The economic impact of capture fisheries development in Indonesia. AACL Bioflux 12(5):1698–1709.
Kunarso D. H., 2011 [Water quality in the Makassar Strait judging from bacteriological aspects]. Journal of Biosfera 28(1):32–42. [In Indonesian].
Mendoza R. U., Valenzuela S., 2017 Growing the Philippine blue economy: Policy challenges and opportunities. ASOG Working Paper No. 17-008, 31 p.
Misuari M. N., Bambang A. N., Purwanto, 2015 [Implementation of blue economy for sustainable fisheries at Tegal Secondary Fisheries Business School]. Journal of Fisheries. Journal Fisheries Science 17(1):35-47. [In Indonesian].
Mosriula, 2018 [Analysis of the suitability and carrying capacity of land as well as strategies for developing seaweed cultivation in Labakkang District, Pangkep Regency, Indonesia]. Journal of Akuakultur, Pesisir dan Pulau-Pulau Kecil 3(2):81–90. [In Indonesian].
Mulyaningtyas D., Niniet I. A., Adhitomo W., Syafrina M., 2020 [Cold chain system analysis with cold storage decentralization strategy on mackerel commodity price stability in Lamongan, East Java with dynamic system simulation approach]. Journal of Applied Business Administration 4(2):148-155. [In Indonesian].
Muhammadi E., Aminullah E., Soesilo B., 2001 [Dynamic system analysis of environmental, social, economic, management]. UMJ Press, Jakarta, 403 p. [In Indonesian].
Nasution M., 2022 The potential and challenges of the blue economy in supporting economic growth in Indonesia: Literature review. Journal of Budget 7(2):340-363.
Nurkholis, Nuryadin D., Syaifudin N., Handika R., Setyobudi R. H., Udjianto D. W., 2016 The economic of marine sector in Indonesia. Aquatic Procedia 7(1):181-186.
Pasaribu E. M., Sardiyatmo S., Trisnani D. H., 2014 [Analysis of factors affecting the price of flyfish (*Decapterus russelli*) at the Nusantara Fishing Port (PPN) Brondong Lamongan, East Java]. Journal of Fisheries Resources Utilization Management and Technology 3(2):94-102. [In Indonesian].

Pudjiastuti S., 2017 [The sea of the nation's future]. Library of KKP, 21 p. [In Indonesian].
Senaratne M., 2020 The blue economy: Charting a new development path in the Seychelles. ORF Occasional Paper No. 265, Observer Research Foundation, 50 p.
Šabić D., Vujadinović S., 2017 Regional development and regional policy. Zbornik Radova - Geografski Fakultet Univerziteta u Beogradu 65(1):463–477.
Samsir A., 2015 [Food security of farmer households in Laikang Village, Magrabombang District, Takalar Regency]. Journal Ecces 2(1):76–93. [In Indonesian].
Spalding M. J., 2016 The new blue economy: the future of sustainability. Journal of Ocean and Coastal Economics 2(2):1-21.
Sterman J. D., 2000 Business dynamics: System thinking and modeling for a complex world. Irwin McGraw-Hill, Boston, 32 p.
Sterman J. D., 1984 Apropriate summary statistics for evaluating the historical fit of system dynamics models. Dynamica 10(2):51-56.
Tambani G., 2008 [Factors influencing the price formation of fishery products]. Pacific Journal 1(3):321. [In Indonesian].
Tasrif M., 2007 [Policy analysis using the System Dynamics model]. Lecture/Course Modules. Program Magister Studi Pembangunan-SAPPK ITB, Bandung, 56 p. [In Indonesian].
Tuck E., McKenzie M., 2015 Place in research: Theory, methodology, and methods. Routledge, New York, 209 p.
Yusuf M., Wijaya M., Surya R. A., Taufik I., 2021 [MDS-RAPS sustainability analysis techniques]. Penerbit IPB Press, Bogor, 206 p. [In Indonesian].
Yusuf M., Nurhamli, Setiawan Y., Supeni E. A., 2020 Decision support system in the 4.0 era: Theory & application of analysis tools. Penerbit IPB Press, Bogor, 260 p. [In Indonesian].
Yulinda E., Saad M., Yusuf M., 2020 A study on the economic potential of blood cockles (*Anadara granosa*) in Rokan Hilir, Riau Province, Indonesia. AACL Bioflux 13(3):1504-1510
*** World Bank, 2017 United Nations department of economic and social affairs. The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries. World Bank, Washington, DC.

Received: 12 November 2023. Accepted: 27 January 2024. Published online: 16 February 2024.
Authors:
Muhammad Yusuf, Department of Agrobusiness, Faculty of Fisheries, Cokroaminoto University of Makassar, St. Perintis Kemerdekaan Km 11, Makassar, 90245 South Sulawesi, Indonesia, e-mail: yusufhalim2014@gmail.com
Andi Samsir, Department of Economics Development, Faculty of Economy and Businness, State University of Makassar, St. Pendidikan I No.27, Tidung, Makassar, South Sulawesi 90222, Indonesia,
e-mail: andi.samsir@unm.ac.id
Siswan Tiro, Perkumpulan Katalis Indonesia, St. Faisal X No.8, Makassar, South Sulawesi, Indonesia, e-mail: siswannoltujuh@gmail.com
Muhammad Ilyas, Marine Affairs and Fisheries Department of South Sulawesi Province, St. Bajiminasa No. 12 Makassar, South Sulawesi, Indonesia, e-mail: ilyasgowa70@gmail.com
Andi Dyna Riana, Department of Agrobusiness, Faculty of Fisheries, Cokroaminoto University of Makassar, St. Perintis Kemerdekaan Km 11, Makassar, 90245 South Sulawesi, Indonesia, e-mail: dynariana78@gmail.com
Amran Saru, Department of Integrated Coastal Resources Management, Post Graduate School, Hasanuddin University, Jl. Perintis Kemerdekaan, Km.10, Tamalanrea Makassar, 90245, South Sulawesi, Indonesia, e-mail: amransaru@ymail.com
Mubariq Ahmad, Conservation Strategy Fund, Graha Simatupang, Tower 2C, 4th Floor St. TB. Simatupang, Kav. 38 Pasar Minggu, Jakarta Selatan, Indonesia, e-mail: mubariq@conservation-strategy.org
Christy Desta Pratama, Conservation Strategy Fund, Graha Simatupang, Tower 2C, 4th Floor St. TB. Simatupang, Kav. 38 Pasar Minggu, Jakarta Selatan, Indonesia, e-mail: desta@conservation-strategy.org

How to cite this article:
Yusuf M., Samsir A., Tiro S., Ilyas M., Riana A. D., Saru A., Ahmad M., Pratama D. C., 2024 Blue economy policy model for encouraging regional growth in South Sulawesi. AACL Bioflux 17(1):272-283.