Sustainability analysis of socio-economic aspects of fishermen's communities reviewed from the human development index in Dumai City

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Abstract. Dumai City is one of the cities in Riau Province, Indonesia, located in the coastal area. As an industrial and trade city, the fisheries sector in Dumai City is under intense pressure due to this marine activity. On the other hand, Dumai City has the second highest Human Development Index (HDI) value in Riau Province after Pekanbaru City. The high HDI status of Dumai City makes it attractive to study whether it is directly proportional to the HDI value of the fishermen community and its socioeconomic sustainability status. The survey method was used in this study. This study aims to analyze the sustainability status of Dumai City's fisheries from social and economic aspects by considering HDI indicators in health, education, and economic aspects. This study uses two analysis methods: the calculation of HDI and sustainability status using Rapfish. The HDI value of the Dumai City fishermen community is 69,35. These results show that the condition of the Dumai fishermen community is still relatively low when measured by the HDI indicator. If examined based on sustainability analysis, the social and economic aspects of the Dumai City fishermen community are 39,56, with a less sustainable status.

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1 Introduction

Dumai City is one of the cities in Riau Province located in a coastal area. This location factor makes the city of Dumai have a population that partly works as fishermen. Fishermen in the waters of Dumai City generally carry out limited fishing in waters within 2 miles of the coast. The total fishery production of Dumai City is 93% from marine fishing efforts and the rest from fisheries and others [1][2]. With almost 300 households dependent on marine capture fisheries, this can contribute to the fishermen community. However, there has been a change in fishing that has increased due to the emergence of the CPO (Crude Palm Oil) and Cement industrial areas around Sungai Sembilan District[3]. This activity will directly or indirectly impact coastal and marine communities, which will cause a decrease in fishermen's catches. Of course, this can cause poverty for the Dumai City fishermen community. Industry is a very dominant sector in the coastal area of Dumai City. This industrial sector is essential in regional development and construction, improving the economy and community welfare [4]. This industrial activity has positive and negative impacts on physical, environmental, and social conditions. According to [3], the entry of several CPO and cement processing companies since 2005 has had a positive impact, such as the Availability of alternative jobs for people in Dumai City, such as becoming laborers. However, work as fishermen around this area is affected by changes in the surrounding area, which will directly or indirectly impact coastal and marine areas. There has been a change in the fishing area where fishermen can initially carry out fishing activities along the Rupat Strait, then shifted towards the outside of the Rupat Strait. Changes in fishing areas must force fishermen to conduct fishing activities far from industrial areas. However, the fleet usually used by fishermen in Dumai City is less than 5GT in size and only supports fishing activities within the nearby area. If conditions like this are not resolved immediately, dumai city's fish catch production will continue declining yearly. It is hoped that there will be appropriate policies to ensure the welfare of the Dumai City fishermen community amidst the rapid development of the industrial sector in Dumai City.

One of the measuring tools for the achievement of community development is the Human Development Index (HDI), a crucial indicator for planning and assessing community development [5]. The HDI is a composite index used to measure the success of development from the aspect of human resources. The HDI covers three development areas: health, education, and the economy. the three are interrelated and influence the community's quality of life [5]. The HDI describes how people can access development outcomes related to income, health, and education and can measure inequality between regions [6].

A Fishermen community development strategy is carried out to improve the welfare of the fishermen community and increase the HDI value. According to UNDP, the development strategy is through the human development model, which can be developed through community empowerment efforts. Community empowerment can be achieved by increasing basic human capabilities, namely health, knowledge, and skills to increase community participation in productive economics, social-cultural, and political activities [5].

For Dumai City, measuring this index is essential for four reasons: the fishermen community development index will be a reference for seeing the level of success of the fishermen community social welfare development program carried out by the Dumai City Government, the fishermen community development index can be used as a tool to assist in regional development planning [5], especially in the fisheries sector, fishermen community development index data is also helpful in assessing the fisheries sector development planning process, and the fishermen human development on its social welfare indicators.

Socio-economic sustainability analysis includes planning to meet current needs without compromising future generations. The HDI can be used as a basis for designing policies that

balance economic growth and improving the quality of life to ensure that all levels of society can enjoy the benefits of development [7]–[9].

The HDI includes important socio-economic indicators such as education, health, and income, critical components in socio-economic sustainability analysis [9], [10]. The higher the HDI of a region, the more likely the area is to have a more robust and inclusive social and economic system, thus having more significant potential to support socio-economic sustainability.

The education and health aspects measured by the HDI are essential elements in achieving socio-economic sustainability because healthier and more educated people are better able to contribute to sustainable economic development. When education and health are improved, economic productivity also increases, which ultimately drives long-term financial well-being.

2 Research Methodology

In this study, the method used was a survey. The survey method was carried out by taking samples from a population and using a questionnaire as the primary data collection tool. Data were collected through a questionnaire prepared in advance, then supplemented with deep interviews and observations.

The number of respondents was determined using the multi stage cluster sampling technique. In multistage sampling, researchers divide the population into clusters and select several clusters in the first stage. In this stage, researchers divide the population into clusters based on geography/areas where fishing communities are located. In each subsequent stage, researchers further divide the selected clusters into smaller clusters until they reach the final step. In the final step, researchers randomly select several members from each cluster chosen to be sampled. The sample size was 40 people from 364 fishermen in Dumai City. Based on the number of fishermen, the sample selected was 40 fishermen, divided into 20 fishermen in Medang Kampai District and 20 people in Sungai Sembilan District.

The sample size was determined by evenly distributing the samples for each district with the most significant number of fishermen in Dumai City, namely Medang Kampai District and Sungai Sembilan District. The difference in the number of fishermen in these two districts is relatively insignificant, with homogeneous characteristics. This Multistage Cluster Sampling technique divides the population of fishermen in Dumai City according to natural characteristics, namely the geographical area of the sub-district. This technique produces an even distribution of samples for each sub-district with the largest population of fishermen. This study also uses expert respondents to determine the fishermen community's sustainable development attributes. Expert respondents are determined by the purposive sampling technique, which takes data sources using specific considerations; someone or something is taken as a sample because the researcher assumes that someone or something has the information needed for his research [11]. In this study, there were seven expert respondents consisting of the head of the Dumai City Fisheries Service, Fisheries Extension Officer of the Dumai City Fisheries Service, Fishermen's Companion of the Dumai City Fisheries Service, Expert Statistician of the Riau Province BPS, Head of the Dumai City Fishermen's Group, and two people from academics (IPB University and Riau University).

Data analysis for determining the HDI of the fishermen community refers to the general HDI calculation using the fishermen's data variable [12]. HDI is calculated based on the geometric mean of the health, knowledge, and expenditure index, referring to the UNDP calculation model. HDI is the geometric mean of the three dimension indices [13].

$$HDI = (I_{Health} \cdot I_{Education} \cdot I_{Income})^{1/3}$$

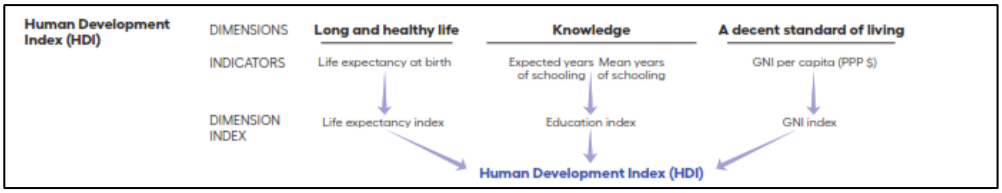

Fig.1. Calculating the human development indices graphical presentation [13]

Sustainability Analysis Using Rapfish Techniques [14][15]. The aspects discussed in this study are the socioeconomic aspect [16]. Comprehensively there has also been a sustainability analysis on ecological and institutional factors. The list of attributes used in Rapfish analysis refers to FAO Circular No. 947 (1999) [17] and enters the HDI attribute. Rapfish is a "good" capture crossing (defined as a 100% sustainable score), which consists of the best score for all attributes in each field of evaluation and "bad" or "worst" scores (defined as a 0% sustainability score), has the worst score [16]. More detailed techniques are given in Tesfamichael and [14], [16]–[18]. Further analysis is carried out to determine the lever factor that has a more significant influence proportionally on the final result. At this stage each attribute in a sequential manner is carried out by MDS analysis so that the leverage attributes is obtained.

3 Results and Discussions

3.1 Dumai City Fishermen Community Development Index

A study was conducted on all indicators of its components to see the status of the development of the Dumai City fishing community. The value of the Dumai City fishing community development index was obtained through the HDI analysis procedure. (Table 1).

Table 1. HDI of Dumai City fishemen community

Life Expectancy Index	Education Index	Economic Index
0,735	0,862	0,484
HDI of Dumai City Fishermen Community		
69,35		

The value of the HDI of the fishermen community in Dumai City in 2023 is still relatively low, when compared to the 2023 Dumai City HDI of 75,66 and the Riau Province HDI of 74,95. Data shows that the condition of the fishermen community in Dumai City is still low when measured through the HDI with indicators of education, health, and economy. The HDI value of the Dumai City fishermen community is very far compared to the general Human Development Index value of Dumai City. The HDI value of Dumai City, with a high status, is not in line with that of the Dumai City fishermen community. This is because the economic indicator of the Dumai City Fishermen community is much lower, namely with a value of IDR 8.311.347/capita/year.

Meanwhile, the general economic indicator of Dumai City, overall community expenditure reaches IDR 12.457.000/capita/year. Compared to the expenditure of the Riau Province community, with IDR 11.448.000/capita/year, the expenditure of the

Dumai City fishermen community still needs to catch up. In the education indicator, the fishermen community's Expected Years of Schooling (EYS) value is only 11,66 years. This value is also relatively low compared to the EYS of Dumai City and Riau Province, which reached 13,33 years and 13,30 years. In the Average Length of Schooling component, the fishermen community of Dumai City only reached a value of 6,67 years, while the RLS of the Dumai City community was 10,16 years and Riau Province was 9,32 years (Table 2).

Table 2. The value of the human development index component

Scope	Life expectancy (year)	Expected years of schooling (year)	Mean years of schooling (year)	Expenditure percapita (IDR)	HDI
Fishermen Communities	70,98	11,66	6,67	8.311.347	69,35
Dumai City	71,67	13,33	10,16	12.457.000	75,66
Riau Province	72,24	13,30	9,32	11.448.000	74,95
Indonesia	72,32	13,15	8,77	11.899.000	74,39

Health indicators for fishermen in Dumai City are assessed based on the availability of health facilities in Dumai City and fishermen can utilize these facilities properly. The health sector development aims to ensure that all levels of society can obtain health services evenly. With this goal, a good level of public health will be achieved to get a healthy and productive life. In line with [4], good health quality is supported by adequate facilities and infrastructure and quality health workers. Mortality, nutritional status, and morbidity are often used to reflect health status. However, until now, data to measure this health status is difficult to obtain because it is incidental, the registration system needs to run better, and public awareness of the importance of reporting each incident still needs to be improved. Therefore, the indicator used to reflect health status in achieving the HDI is Life Expectancy at Birth (LEB). This figure reflects the average years a person will live since birth. High life expectancy will be achieved if the population has good health status. Health is an essential factor in human development and is the basis for growth in other fields. Healthy people are a prerequisite for realizing people-centered development. Handling health problems can only be done in stages related to all existing limitations regarding funding and available resources. With such conditions, priority programs and activities need to be carried out. In addition, handling health problems is not only the health sector's responsibility but is a shared responsibility between the government and the community. The availability of adequate health facilities and infrastructure will greatly support public health services.

Free health services can make it easier for people to use health facilities such as health centers. With the availability of free health services, people no longer hesitate to visit and use health center facilities [19]. Efforts to improve health are not only about building health facilities but also must be accompanied by good quality health services. One crucial element that determines the success of health development is the availability of health facilities [19]. Through the availability of adequate health facilities and infrastructure by the government, the fishermen community of Dumai City feels that there are no significant problems related to health services in their environment. All communities receive good health services through existing health workers. However, fishermen communities are worried when work accidents occur at sea. They worry about what kind of first aid should be done; fishermen need help with first aid after an accident. The quality of a person's health reflects the quality of their human being.

For this reason, health development is an inseparable part of human development. The ultimate goal of health development is to realize an optimal level of public health as one of the elements of general welfare [19]. Health development programs are directed at improving the quality of human resources, the quality of life, and life expectancy and increasing public awareness of the importance of healthy living. The target of the health development program in this study is more emphasize on low-income fishermen communities and community groups far from the center of government. The role of the fishermen community must be increased through integrated health management. In terms of quantity and quality, the provision of various health facilities, health workers, and the provision of drugs also continues to be improved.

Strategic, synergistic, and sustainable development planning greatly influences the achievement of development results. The calculation of the HDI of Dumai City fishermen's community is carried out by continuing to use the basic principles of calculating the HDI. However, several modifications were made due to data availability and technical limitations. One of the differences is in the calculation of Life Expectancy at Birth. The calculation of Expectancy at Birth refers to the value of the Life Expectancy at Birth figure for Dumai City as a whole, assuming that the figure is the number of years a newborn is expected to survive. The pattern of infant mortality according to age at birth is the same throughout the baby's life. Based on these data, the health index of the Dumai City fishermen's community is 0,7943. In the health indicator, the life expectancy of the fishermen community is categorized as high (above 65 years). An increase in the quality and quantity of facilities, infrastructure, and health services for the fishermen community supports this.

3.2 Sustainability Analysis of Socioeconomic Aspects of Fishermen Communities

Sustainability Analysis of the socioeconomic aspects of the fishery community starts with determining sustainability attributes. The socioeconomic sustainability attributes are taken from the [14] and the results of the previous HDI study. Socioeconomic sustainability attributes include price, fisheries in GDP, Expenditure per capita, fishing income, marketable right, other income, sector employment, ownership, market, subsidy, fishermen community growth, education level/EYS, conflict status, and life expectancy.

The results of the analysis of the sustainability of socio-economic aspects in the fishermen community of Dumai City are in a less sustainable condition. The sustainability index value is 39,56. The results of the analysis of socio-economic sustainability using the Rapfish technique are shown in Figure 2.

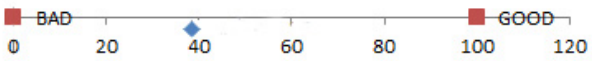

Fig.2. Sustainability index value of socio-economic dimension

Based on the results of the leverage analysis in Figure 3, Three attributes were obtained that were sensitive to the value of the socio-economic dimension sustainability index: fishing income, sector employment, and expenditure per capita. The sustainability of the socioeconomic aspects of the fishermen community is primarily determined by mainstreaming the fishery's human dimension and rethinking governance, policies, and compliance [20], [21]. At the policy implications level, recommendations are needed on priority scales to improve sustainability status [22].

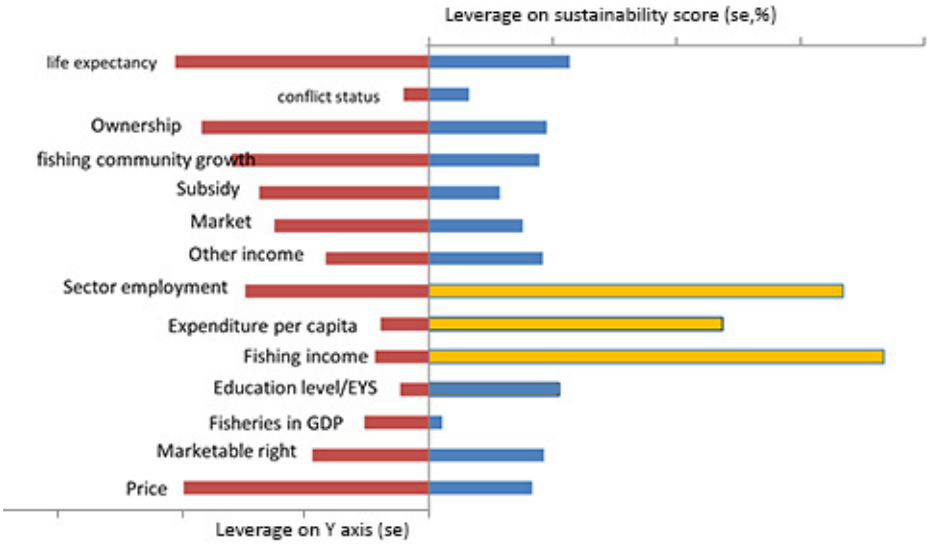

Fig.3. Leverage analysis results

3.2.1 Fishing Income

Some of the causes of the low income of fishermen in the city of Dumai include lack of access to fishermen's fleet technology and facilities that support fishing and fish management operations; in addition to the development of superior commodities, Dumai fishermen communities have a dependency on a small number of fish species that are vulnerable to fluctuations in stock and markets. As a result, the diversification of fishery products in the city of Dumai needs to be improved. Dumai fishermen also need more innovation in developing fishery products with high-added value. Technology and innovation factors are one of the determinants of economic improvement [23].

3.2.2 Sector Employment

Dumai City, as one of the industrial cities and main ports in Riau Province, has complex labor dynamics. Although the city's economy is quite advanced, there are still significant imbalances in the employment sector. This inequality can be seen from several aspects, such as wage differences, access to work, and differences between industrial sectors. Inequality in the employment sector in Dumai City is very high. Inequality is because many companies and industries are active there. Some sizeable international capacity industries stand in the Dumai Beach area, such as the Pertamina Dumai oil refinery, PT. Chevron Indonesia, an oil palm processing company, the processing of wood raw materials, and the Port of Port activities to load goods and people. The number of large companies with high salaries causes several primary sectors to be less interested, like fishermen. Based on data analysis in the field information on the decline in the number of workers in the fisheries sector. Therefore, cross-sectoral collaboration is needed to reduce this gap [24]. Large companies can encourage increased income for fishermen through CSR programs. The government can also play a role through fiscal policy.

3.2.3 Expenditure Per Capita

The fishermen community's high expenditure per capita in Dumai City results from various factors such as significant operational needs, increased living costs, and the influence of technology and consumption patterns. Nevertheless, the fisheries sector is still the main foundation of the economy of the Dumai City fishermen community, and sound financial management is critical to maintaining the welfare of the fishermen community in this region.

4 Conclusions with Relevant Policy Recommendations

Based on the research results, the HDI of the fishermen community in Dumai City was recorded at 69,35, which shows that the welfare of the fishing community is still relatively low compared to the overall HDI of Dumai City. Although Dumai is a port and industrial city with substantial economic potential, this sector has yet to significantly contribute to improving the fishermen community's quality of life. Furthermore, other research results show that the sustainability analysis of the social and economic aspects of the fishermen community is at a score of 39,56, which is included in the less sustainable category. Three primary attributes are most sensitive to the sustainability index value in the social and economic dimensions: fishermen's income, sectoral employment, and per capita expenditure. Low fishermen's income, limited sectoral employment outside of fisheries, and low per capita expenditure influence this low level of sustainability. This condition emphasizes the need for strategic policies that can improve fishermen communities' welfare and economic sustainability to be better and more inclusive.

Recommendations for the socioeconomic sustainability strategy for fishermen in Dumai City must focus on income diversification, access to technology and capital, reducing inequality in the employment sector, and controlling per capita expenditure. Policies that support strengthening cooperatives, infrastructure development, and social protection are also critical to encouraging long-term welfare for fishing communities. Collaboration between the government, the private sector, and international institutions will be the key to realizing economic and social sustainability for the fishermen community in Dumai City.

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References

1. M.N. Arkham, Y. Krisnafi, R.Y.F. Hutapea, S.A. Ikhsan, M.Tiku, R.S. Mardiah, P.P. Kelana, R.B.K. Haris, The social-ecological dynamic of small-scale fisheries in Coastal Area of Dumai City. IOP Conf. Ser. Earth Environ. Sci. **967**, 1 (2022). https://iopscience.iop.org/article/10.1088/1755-1315/967/1/012040
2. L. Asna, B. Bustari, A.H. Yani, Study of Belat Fishing Gear in the Waters of Dumai, Riau Province. J. Coast. Ocean Sci. **4**, 2 (2023). https://doi.org/10.31258/jocos.4.2.94-99
3. H. Nufus, Konsentrasi Minyak Sawit Mentah (CPO) di Kawasan Pesisir Dumai Provinsi Riau. J. Perikan. Terpadu. **1**, 1 (2018). https://doi.org/10.35308/.v1i1.756
4. E.J. Lugina, A.B.S. Mwakalobo, F. Lwesya, Effects of industrialization on Tanzania's economic growth: a case of manufacturing sector. Futur. Bus. J. **8**, 1 (2022). https://doi.org/10.1186/s43093-022-00177-x

5. A. Ambya, Human Development Index (HDI) in Lampung Province Period 2013-2018. Sriwij. Int. J. Dyn. Econ. Bus. **4**, 2 (2021). https://doi.org/ 10.29259/sijdeb.v4i2.119-128
6. N. Hendajany, D.R. Riyadi, Determinants of Regency/City Typology Based on HDI Indicators: Case from West Java, Indonesia, J. Reg. Rural Dev. Plan. **6**, 3 (2022). https://doi.org/10.29244/jp2wd.2022.6.3.249-261
7. M.R.N. Sagara, M.M. Sari, I.Y. Septiariva, I.W. K. Suryawan, Relationship between Human Development Index and Gross Regional Domestic Product on Sanitation Access in East Java Region in Achieving Sustainable Development Goals, J. Perenc. Pembang. Indones. J. Dev. Plan. **6**, 2 (2022). https://doi.org/10.36574/jpp.v6i2.298
8. A.I. Fahrika, H. Salam, M.A. Buhasyim, Effect of Human Development Index (HDI), Unemployment, and Investment Realization toward Poverty in South Sulawesi-Indonesia, Int. J. Soc. Sci. World. **2**, 2 (2020). https://doi.org/10.5281/zenodo.4080749
9. P. D. Priyatno, F. Yetty, L. Puspita Sari, A. Zahran Rizqulloh, Welfare Analysis Through Human Development Index with Maqasid Sharia Approach. J. Islam. Econ. Financ. Stud. **4**, 2 (2023). https://doi.org/10.47700/jiefes.v4i2.6831
10. M. Sinaga, R.S. Zalukhu, The Impact of Poverty and Human Development Index on Inequality of Income Distribution of Regency/City in North Sumatra. Int. J. Econ. Manag. Res. **1**, 2 (2022). https://doi.org/10.55606/ijemr.v1i2.89
11. M. Patel, N. Patel, Exploring Research Methodology. Int. J. Res. Rev. **6**, 3 (2019)
12. T. Ramadona, F. Septya, Darwis, P. Rengi, C.W. Yanti, N.E. Darfia, Human Development Index (HDI) of the Fisherman Community in Ransang Island Indonesia. IOP Conf. Ser. Earth Environ. Sci. **934**, 1 (2021). https://doi.org/10.1088/1755-1315/934/1/012046
13. UNDP, Human Development Report: Technical Notes, (Undp.Org, 2020)
14. T.J. Pitcher, Rapfish, A rapid appraisal technique for fisheries, and its application to the code of conduct for responsible fisheries. FAO Fish. Cicular. **947**, 52 (1999)
15. T. Ramadona, P. Rengi, T. Warningsih, F. Septya, S.M. Ngesti, A. Purnomo, Does Capture Fisheries in the Vicinity of Tin Mining Area Sustainable?: A case study in Bangka Island, Indonesia. IOP Conf. Ser. Earth Environ. Sci. **430**, 1 (2020). https://doi.org/10.1088/1755-1315/430/1/012015
16. D. Tesfamichael, T.J. Pitcher, Multidisciplinary evaluation of the sustainability of Red Sea fisheries using Rapfish. Fish. Res. **78**, 2–3 (2006). https://doi.org/10.1016/j.fishres.2006.01.005
17. T. J. Pitcher, D. Preikshot, RAPFISH: A rapid appraisal technique to evaluate the sustainability status of fisheries. Fish. Res. **49**, 3 (2001). https://doi.org/10.1016/S0165-7836(00)00205-8
18. P. Kavanagh, T. J. Pitcher, Implementing Microsoft Excel Software For Rapfish: A Technique for The Rapid Appraisal of Fisheries Status. Fish. Cent. Res. Reports. **12**, 2 (2004)
19. R. Fitriati, K.P. Rahmayanti, Government Support in Triple Helix Collaboration to Provide Health Service Delivery: Case Study Government Hospital in Bengkulu Hospital. Procedia-Soc. Behav. Sci. **52**, (2012). https://doi.org/10.1016/j.sbspro.2012.09.452

20. D. Agustian, E.N. Megantara, Y.N. Ihsan, M.F. Cahyandito, Sustainability of Social, Economic, and Institutional Aspects on Fisheries Management: Case Study at Palabuhanratu Nusantara Fishing Port, West Java. Econ. Soc. Fish. Mar. J. **011**, 01 (2023). https://doi.org/10.21776/ub.ecsofim.2023.011.01.02
21. S.J. Cooke, E.A. Fulton, W.H.H. Sauer, et al., Towards vibrant fish populations and sustainable fisheries that benefit all: learning from the last 30 years to inform the next 30 years. Rev. Fish Biol Fisheries. **33**, 2 (2023). https://doi.org/10.1007/s11160-023-09765-8
22. K. Widyawati, C. Kusmana, S. Pertiwi, B. Sulistyantara, Rapid Assessment of the Sustainability Status of Tourism Area Management Through MDS-Rapfish R in Situ Rawa Kalong, Depok City, West Java, Indonesia. Int. J. Sustain. Dev. Plan. **19**, 6 (2024). https://doi.org/10.18280/ijsdp.190606
23. J. Wen, C.V. Okolo, Does global economic reform accentuate technological innovation? A comparative evidence around the world. Econ. Res. Istraz. **36**, 3 (2023). https://doi.org/10.1080/1331677X.2023.2264371
24. N. Stacey, E. Gibson, N.R. Loneragan, C. Wareen, et al., Developing sustainable small-scale fisheries livelihoods in Indonesia: Trends, enabling and constraining factors, and future opportunities. Mar. Policy. **132**, 104654 (2021). https://doi.org/10.1016/j.marpol.2021.104654