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Analysis of the Physics Concept of Rigid Body Equilibrium on Banyuwangi Cadik Boat Bimorejo

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Abstract: Indonesia has a lot of local culture in the marine sector, which is starting to disappear due to the impact of globalization, one of which is the Cadik boat located in Bimorejo Village, Banyuwangi. The purpose of this research is to analyze the concept of equilibrium physics on the Cadik boat. This type of research is qualitative research with interview, observation and documentation data collection methods. The data were analyzed using content analysis which consisted of seven stages, including Defining the research question, defining the population and samples, defining the units of analysis, deciding the codes, constructing the categories, conducting the data analysis, and creating inferences. The results showed that there was an equilibrium concept on the Cadik boat. The body of the boat and the outrigger provide equal and opposite forces to fulfil the equilibrium requirements $\Sigma F = 0$ and the outriggers on the sides of the boat have the same mass and length, thus fulfilling the equilibrium requirements $\Sigma \tau = 0$. This research is expected to provide a new perspective for teachers and students so that physics learning is more contextual and meaningful.

Keywords: Outrigger boat; Concept of equilibrium; Physics learning.

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Introduction

Culture is the result of human creations that are inherent and become a way of life for a group of people and contain meaning, moral values that are passed down from generation to generation (Laos & Tefi, 2019). Rapid changes in technology and information have shifted traditional culture to a modern culture that lacks integrity. Overexploitation of natural resources by utilizing advanced technology will result in unequal material wealth. This is related to the existence of culture in Indonesia (Setiawan, 2016; Abidin, 2006). The impact of the development of information technology in the era of globalization is the change in the cultural values of a society, which includes the loss of the original culture of a region or a country.

Indonesia is one of the countries that has the value of local wisdom in the maritime sector which is very broad and if it is developed it will be a development capital towards the prosperity of the nation, but the road to achieving this is still experiencing challenges, including problems with facilities and infrastructure for adequate infrastructure in Indonesia and development information technology is very fast (Kadar, 2015). As an archipelagic country that has a wide sea and a long coastline, the maritime and marine sector is very strategic for Indonesia, especially as a world trade center that utilizes boat transportation as a means of life. Boats are seen as embodiments of the maritime needs and traditions of the community built within the context of appropriate needs. Boats represent social factors and environmental conditions consisting of ideology, tradition, and economy (Adam, 2013).

Al-Fiqri (2020) stated that the traditional archipelago boats that have survived to this day are the outrigger boats with a side rudder system placed on the

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left and right sides of the ship's stern, and the mounting system is tied to a long board that serves as a support for the steering wheel. firmly held. Outrigger boat is a boat equipped with a balancing device on the right and left sides of the boat. The purpose of the addition of outriggers so that the boat becomes balanced and does not sink. This is as stated by Sulasminingsih (2017), the outrigger is part of a boat made of bamboo and installed outside the hull parallel to the hull of the boat which aims to balance the boat's motion.Outrigger Boat in Bimorejo VillageBanyuwangi Regency is one of the local wisdomsused by fishermen who still exist today even though the existence that is maintained is in a dynamic state (Figure 1).

Figure 1. Outrigger boat sailing in Bimorejo Village
Source: Personal documentation

Physics itself is a part of science that explains observable phenomena based on human experience, rational thought, and experiments in detail (Suwindra, 2012; Handayani, 2021). Existing learning should be able to make students understand and apply the knowledge they already have in everyday life, especially on local wisdom which is indeed the uniqueness of every region in Indonesia (Makheasy et al., 2019). Understanding the concept of physics will be easier if students are faced with learning that relates to problems in everyday life, so that a more contextual and meaningful learning is created (Ilyas & Liu, 2020). Physics as one of the subjects in the field of Science which contains various concepts that can be used as the basis for thinking and formulating higher thinking processes so as to create certain principles and generalizations for students' understanding (Suhendi et al., 2018).

Integrating ethnoscience into physics learning is the same as integrating everyday knowledge into physics subjects. Because according to Treswati (2018), indigenous knowledge can be interpreted as people's behavior in utilizing three natural materials to maintain environmental balance, meaning that ethnoscience is very closely related to everyday life. The application of the physics concepts being taught needs to be conveyed to students. The lack of application of physics concepts in everyday life makes students think physics is a difficult subject (Syukri et al., 2021).

Existing learning should be able to make students understand and apply the knowledge they already have in everyday life, especially on local wisdom which is indeed the uniqueness of every region in Indonesia (Makheasy, et al., 2019). One alternative for contextual learning is to present a concept that links the subject matter studied by students with the context of everyday culture, so that the subject matter will be more enjoyable because students apply the subject matter presented through the context of their lives (Saregar, et al., 2016; Sahara et al., 2020). By integrating everyday knowledge into physics subjects, it is hoped that students will understand physics concepts more easily and contextually.

This research is based on previous research that is relevant to the research topic being researched. Previous studies that have been carried out include Rochyat (2020) which examines the value of outriggers on the south coast of Java Island, research conducted by Helmi (2016) on the analysis of outrigger installation on 3 GT fishing boats in terms of engine power, and Rubiono's (2020) research on reducing risk and increasing work efficiency of sailboat fishing groups in Alasrejo Village, Wongsorejo, Banyuwangi Regency. Based on this research, research ideas were obtained to analyze the physics concepts contained in the two outriggers. Analysis of physics concepts can be used as a reference for more contextual learning of physics, especially the concept of equilibrium physics. The concept of equilibrium physics is found in both outriggers installed on the right and left sides of the boat, as well as the body of the boat which provides the same force so as to create an equilibrium of the boat when sailing. The purpose of this study was to analyze the concept of equilibrium physics on the Cadik boat in DesaBimorejo Banyuwangi Regency.

Method

The type of research used is qualitative research using a content analysis approach. The object studied is the existence and concept of equilibrium physics on the outrigger boat. The time and place of the research was carried out in Bimorejo Village, Banyuwangi Regency in November-December 2021. Bimorejo Village was chosen as the research site because Bimorejo Village was the forerunner of fiberglass outrigger boats in Banyuwangi Regency.

The research instrument consisted of an observation guide, and an interview guide. Data were collected through the methods of observation,

interviews, and documentation. Observations were made to determine the physical shape of the outrigger boat, its components, how to manufacture it, and to observe the concept of equilibrium physics. Interviews were conducted to 5 resource persons consisting of the Head of the Fish Cultivation Group (POKDAKAN) and 4 fishermen who build Cadik boats in Bimorejo by asking a number of questions that have been listed in the interview guide. The interview used in this study is a semi-structured interview. Along with observations and interviews, the documentation process is carried out to facilitate researchers in processing research results.

The research data were then transcribed before the data analysis process was carried out. The data analysis method chosen in this study is content analysis. Content analysis is a systematic and objective method that emphasizes written, oral or visual communication analysis (Elo & Kyngs, 2008). The stages of content analysis are presented in Figure 2.

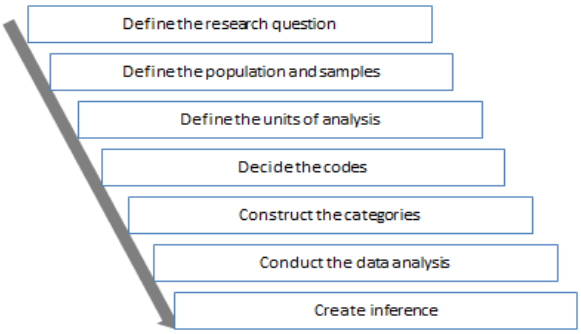

Figure 2. Data Analysis Stages

Define the research question

By using the 5W + 1H guidelines the researcher determined the research questions as outlined in the interview guidelines. The goal is that the questions given do not deviate from the object under study.

Define population and

In qualitative research does not use the term population and sample. It's just that more to the informants or respondents who will provide information about the object of research on the Cadik boat. The selection of resource persons was based on the informant's knowledge of the Cadik boat. So that the selected informants in the Cadik boat research came from fishermen and boat builders.

Define the units of analysis

Determine the unit to be analyzed. The outrigger boat has its own uniqueness because it has a balancing arm to stabilize the boat's motion while sailing, so that the boat will return to its original position after experiencing a slope. The physics concept on the Cadik boat analyzed is equilibrium.

Decide the codes

Determination of the code aims to facilitate the process of grouping research data.

Construct the categories

Creating categories aims to map the findings in the study. This process was used in the Cadik research boat to narrate and report some of the findings.

Conduct the data analysis

The results of interviews conducted to 5 resource persons were in the transcript, then analyzed using a content analysis approach to explore the concept of equilibrium physics on the Cadik boat.

Create inference

After analyzing the concept of equilibrium physics on the Cadik boat, the next step is to produce conclusions in the form of a research draft that can be used as a reference for learning physics, especially the concept of equilibrium.

Results and Discussion

Physics is one of the natural sciences that explains observable phenomena based on human experience, rational thought, and detailed experiments (Suwindra, 2012).This research is a qualitative research on content analysis of equilibrium physics concepts on Cadik . boatsin Bimorejo Village.

Functionally the Cadik boat is used as the main equipment in terms of livelihoods for the people of Bimorejo Village. Outriggers mounted on the right and left sides of the boat are used as the main security against storms and big waves in the middle of the ocean. Almost the entire community of Bimorejo Village has expertise in making outrigger boats. For Bimorejo Fishermen, the expertise in making outrigger boats, which has been passed down from their ancestors, has become deeply rooted in a culture in Bimorejo Village. This is the characteristic of the coastal community of Bimorejo Village.

The outrigger boat in Bimorejo Village is estimated to have existed since the 19th century, namely in the 1960s until now. The outrigger boat that was used for the first time in Bimorejo Village was an outrigger boat with a wooden base which has supporting arms on the right and left sides made of bamboo and the driving force is a sail. The following are the results of interviews conducted with SA and SF resource persons regarding the history of the Cadik boat in Bimorejo Village,

"Outrigger boats in Bimorejo Village existed in the 1960s or could even be older than that. But what is certain is that its history is passed down from ancestors. In the past, some of the boats used one outrigger and some used two as well. I myself started using the Cadik boat in 1991" (Interview with SA, 29 November 2021).

"Historically, the outrigger or katir boat in Bimorejo Village actually started from our ancestors. So if you say the year you remember the old stories, yes, from the 60's it already exists. At first, yes, there was one outrigger and two outriggers. But now the majority have used two. I personally used this outrigger boat from the 2000s" (Interview with SF, 28 November 2021).

The components on the outrigger boat that affect the balance are the outrigger and the outrigger. Brayungan is made of teak and meranti, while the outrigger is made of ori or pethung bamboo. Based on the results of interviews conducted with fishermen and boat builders, the selection of materials used is based on the strength, durability, and durability of the wood. Wulandari (2019) in his research stated that pethung bamboo has good properties to use, including strong stems, ductile, straight, flat, hard, easy to split and easy to shape.

Furthermore, the results of the interview also show that the boat builders indirectly know that there is a concept of equilibrium physics in the outrigger boat. This knowledge is only limited to the concept of knowing, not to physical studies.McKinley & Stewart (2012)states that, the local community essentially has scientific knowledge which is manifested in the form of practical skills and simple knowledge. This knowledge is derived from experience and observations, but sometimes it cannot be explained scientifically(Baquete et al., 2016; Handayani et al., 2019).

Furthermore, the discussion of the concept of equilibrium in the research that has been carried out is divided into two parts, namely equilibrium before sailing and when sailing. The first discussion is the balance of the Outrigger boat before sailing. Based on the results of interviews conducted with the informants, boat equilibrium occurs when there is an outrigger movement up and down, right and left with equal strength and offset each other. This opinion can be strengthened by referring to Newton's Law, namely an object that moves in a straight line (translation) will reach a state of equilibrium if it meets two equilibrium requirements. The first condition refers to Newton's First Law, which states that the sum of all the forces acting on the object must be zero (F = 0). The second requirement is that the sum of all torques (moments of force) acting on all objects calculated about any axis must be zero ($\Sigma\tau = 0$) and the object has no tendency to rotate. This condition is based on the dynamics of rotational motion which is exactly the same as the equilibrium conditions in Newton's First Law. An illustration of the equilibrium on the Outrigger boat can be seen in Figure 3.

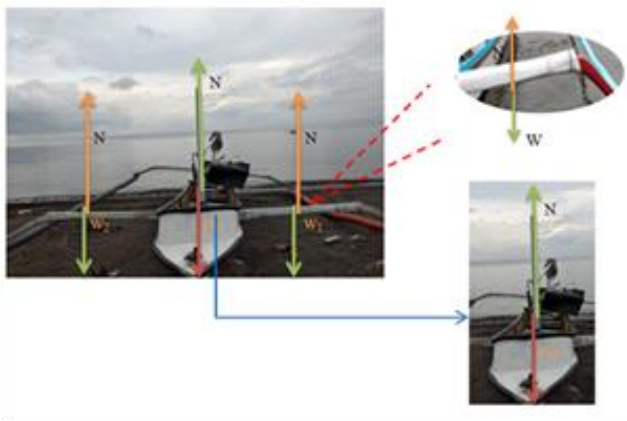

Figure 3. The boat's equilibrium F = 0

Based on the analysis of the image above, it can be observed that the magnitude of the gravity (W) which is influenced by the gravitational force has the same magnitude, both the gravity generated by the boat body and the gravity generated by the boat outrigger. Therefore, to achieve the first equilibrium condition, the magnitude of the gravity must be equal to the normal force exerted by the boat in the opposite direction.

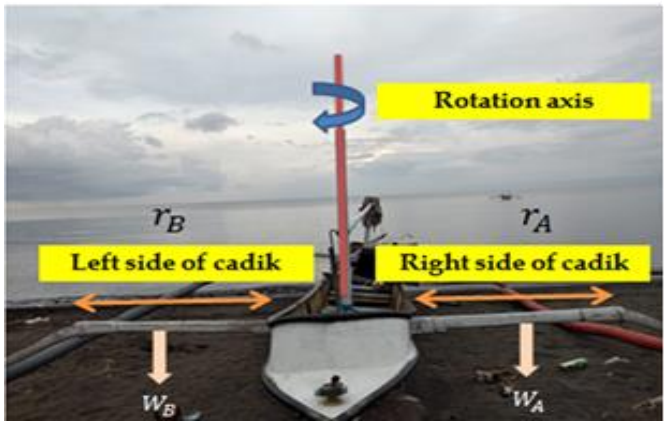

Figure 4. Equilibrium boat = 0

Furthermore, Figure 4 above shows an illustration of an outrigger boat that applies the second requirement to reach an equilibrium position, namely the sum of all working torques is equal to zero ($\Sigma\tau = 0$) (Giancoli, 2014). This equilibrium condition means that the moment of force acting on both sides of the outrigger must be zero so that the magnitude of the moment of force can be found using the equation for all objects calculated about any axis, must have a value of zero and

objects must have no tendency to rotate. Therefore, to achieve equilibrium conditions on the outrigger boat, the magnitude of the moment of force exerted by the right outrigger must be equal to that of the left outrigger. $W_A.r_A = W_B.r_B$. This is in accordance with what was found by Calabrese et al. (2012), i.e. the boat can floatindependently if two equilibrium conditions are met, namely: total weight equals buoyancy, where the center of buoyancy lies on the same vertical line. So the key to getting to an equilibrium position is to balance all the forces acting on it.

Furthermore, the balance of the outrigger boat cannot be separated from the center of gravity owned by the outrigger boat. The center of gravity of the outrigger lies on the x-axis and y-axis. The center of gravity in the area dimension results from the overall length of an object. Through the calculation of the center of gravity, it can make it easier for the fishermen of Bimorejo Village to place the outrigger in the right position, so that the boat can achieve a good equilibrium condition. The location of the center of gravity on the outrigger is illustrated in Figure 5.

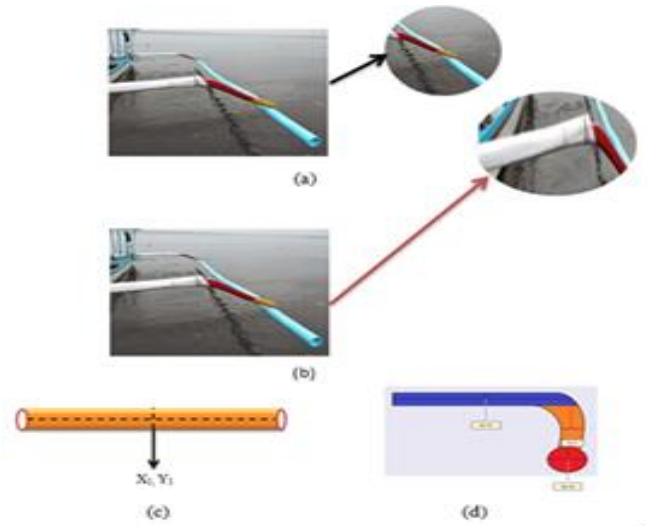

Figure 5. Center of gravity on outrigger

Based on interviews that have been conducted with fishermen from Bimorejo Village, there are many obstacles that affect the balance of the boat, including the shape of the body of the boat, the size of the outrigger that is installed across the body of the boat, the strength of the wind, and the height of the waves. To find out the equilibrium of the Cadik boat, it is necessary to do a test through video capture on the Cadik boat when it is at the dock. The test serves to determine the angle of inclination and the time it takes the boat to return to its original position. This is as research conducted by Matafi et al, (2015) that the things that affect the balance of the boat can be grouped into two major groups, namely external factors which include the layout of goods/cargo, the shape of the boat size, leakage due to aground or collision,

Hull Shape

The slender shape of the outrigger boat is an obstacle to its balance. Therefore, outriggers were added on both sides of the boat which were designed in such a way as to be able to maintain the balance of the boat. The body of the boat is deliberately made slim to make it easier for the boat to break the waves, so it doesn't require great force and pressure so that the boat can go smoothly because the obstacles received by the boat are getting smaller. The slim design of the boat certainly affects the balance of the boat, so the outrigger is the right solution for the balance of the boat. Figure 6 presents an illustration of the cross-sectional area of the outrigger boat hull.

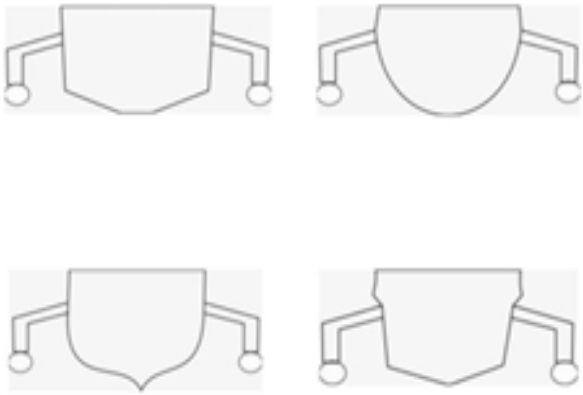

Figure 6. Illustration of Pthe Difference in Cross-sectional Area of the Outrigger Boat

The results of interviews conducted with SF resource persons as Cadik boat users in Bimorejo Village also said that the slim body of the boat made it easier for fishermen to break the waves.

> "Yes, because if the boat's body is slender, the term is more agile and fast. Splitting the waves is better with a slim boat body. Moreover, there is already an outrigger, so even though the surface of the boat is not wide, it can still be safe and balanced (Interview with SF, 28 November 2021)".

The results of the interview above produce a meaning that the slimmer or smaller the cross-sectional area of the boat body, the greater the resulting speed. Kim et al. (2020) states that the slender or slightly slender hull of the fishing vessel facilitates the movement or speed of the vessel in maneuvering.

The design of the Cadik boat hull in Bimorejo Village with a slim body aims to reduce the water surface area due to the emergence of turbulence under the hull, increase the lifting force, reduce drag and increase efficiency, reduce engine speed and reduce fuel

requirements (Oni & Utama, 2015). From the statement above, it can be seen that the smaller the hull of the boat, the greater the resistance generated. Obstacles will affect the balance of the boat, so an outrigger is installed to help balance it.

Outrigger Size

Physically, the size of the outrigger can affect the balance of the boat body. The determination of the physical size of the outrigger can be known by referring to the weight of the boat, but for fishermen in Bimorejo Village, the size of the outrigger used is adjusted to the size of the boat's body. The fishermen of Bimorejo Village do not have a validated standard for calculating the size of a boat. The shape and size used comes from his experience in making boats for a long time. The SA source as a wooden and fiber boat maker said that there was no special training in making outrigger boats:

"There is no training here, Ms. At first, people made it, then over time, you could do it yourself. From actual experience. The size used starts from an estimate. If the size is good and fits well, that's the benchmark (Interview, SA, November 30, 2021)".

Based on the results of interviews conducted with SF, the size of the outrigger adjusts to the length of the boat's hull in order to create harmony in the motion of the boat,

"The size of the outrigger adjusts to the size of the body of the boat because its function is for balance. So adjust to the length of the hull of the boat. If the outrigger is shorter than the length of the boat's hull, the ability to withstand the pressure of large waves will be reduced because the function of the outrigger is to synchronize the movement of the ship or boat" (Interview with SF, 28 November 2021).

The description above shows that with the addition of outriggers, the stability of fishing vessels can be improved. According to Prastowo (2012) ships using outriggers have a positive effect, namely the reduced response of ship movements to waves for both heave, roll, or pitch motion, so it can be concluded that the overall outrigger has a good influence on the ship. Therefore, the double outrigger boat was chosen as the main means of transportation for the people of Bimorejo because it is more balanced and resistant to waves compared to the boat without outrigger.

"If you use an outrigger, it will cause a shock because the waves are not felt too much. If you use the outrigger boat, sis, looking for fish everywhere is good because there is a balance, the shaking is not too loud (Interview, SH, 01 December 2021)".

Wind Power

The fishermen of Bimorejo Village do not have knowledge about boat stability, so when building a boat they do not do a boat stability quality test first. Thus, it is necessary to do a simple test on the movement of the boat to determine the equilibrium quality of the outrigger boat while sailing. The degree of inclination of the boat is also affected by the high and low winds blowing on the shoreline. Generally, fishermen in Bimorejo Village use the east wind when they go to sea because the wind speed is not too big, so the sea waves are calmer. The high wind speed has an impact on the balance of the Outrigger boat. The results of interviews conducted with resource persons SH and SR regarding the effect of waves on fishermen's time in fishing,

"Usually fishermen here go out to sea in December, January, February, March, April. In May the waves are already big, the wind is from the south. So rarely - rarely work. So now the wind is from the east, so there is no wave resistance, wind resistance. If the south wind is where the waves are big, the wind is big. Yes, if the waves are too big, you can't do it, because it's not comparable to the boat" (Interview with SH, 01 December 2021).

"The east wind starts from December to April. That's good, the waves are not too big, so you can catch a lot of fish" (Interview with SR, 29 November 2021).

The results of research conducted by Stewart (1997) stated that there were changes in the wind that had an impact on the strength of ocean waves. There is a correlation between wind strength and water wave height. The stronger the wind that blows, the bigger the waves and this affects the boat's balance.

Based on the test of the tilt angle on the boat, the equilibrium of the Outrigger boat can be observed in Figure 7.

Figure 7. The real Condition of The Outrigger Boat When It Hits an Obstacle

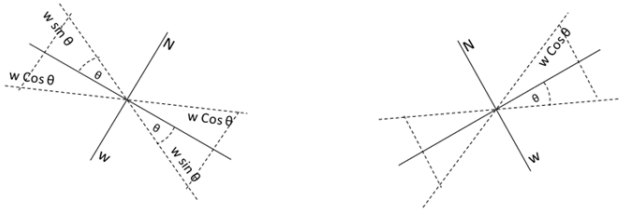

Figure 8. Cadik Boat Tilt Illustration

The illustration in figure 8 shows that the tilt angle of the outrigger boat will vary according to the size of the ocean waves. The addition of an outrigger to the body of the boat serves as a balance between the boat and the alignment between the boat and the current and wave patterns. With the outrigger, it can be observed that the diverse patterns of the archipelago's waters require a type of transportation that functions in all kinds of marine situations. The addition of outriggers also adjusts to the size of the boat used. Outrigger boats in Bimorejo Village are classified as small boats with a load of 5-7 people, so the slender hull of the boat requires outrigger support. The different shapes of the outriggers have the same function, which is to balance the boat.

Conclusion

Outrigger boats in the Bimorejo community, Banyuwangi Regency, contain the concept of equilibrium physics. The balance contained in the boat resulted in the addition of outriggers on the right and left sides of the boat. The up and down movement of the boat outrigger can create equilibrium, because both outriggers exert the same force. Equilibrium analysis on the Cadik boat is viewed from the condition of the boat before sailing and when sailing. The balance of the boat before sailing will reach an equilibrium condition if it meets the equilibrium requirements F = 0 and = 0. There are many factors that affect the balance of the boat, namely the shape of the boat body, the size of the outrigger, and the strength of the wind.

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References

Adams, J. (2013). *A Maritime Archaeology of Ship: Innovation and Social Change in Medieval and Early Modern Europe*. Oxford: Oxbow Book.

Adrian, H., & Resmini, W. (2018). Pengaruh Globalisasi Terhadap Nilai-Nilai Budaya Pada Rumah Tradisional Masyarakat Sade Lombok Tengah. *CIVICUS:Pendidikan-Penelitian-Pengabdian Pendidikan Pancasila dan Kewarganegaraan*, 6(2), 13-22. https://doi.org/10.31764/civicus.v6i2.670

Baquete, A. M., Grayson, D., & Mutimucuio, I. V. (2016). An Exploration of Indigenous Knowledge Related to Physics Concepts Held by Senior Citizens in Chókwé, Mozambique. *International Journal of Science Education*, *38*(1), 1–16. https://doi.org/10.1080/09500693.2015.1115137

Calabrese, F., Mancarella, L., Zizzari, A. A., & Corallo, A. (2012). A FEA-like method for evaluating the ship equilibrium point. In *IFAC Proceedings Volumes (IFAC-PapersOnline)* (Vol. 9, Issue PART 1). IFAC. https://doi.org/10.3182/20120919-3-IT-2046.00020

Elo, S., & Kyngas, H. (2008). The Qualitative Content Analysis Process. *Journal of Advanced Nursing*. 62(1): 107:115. https://doi.org/10.1111/J.1365-2648.2007.04569.X

Handayani, R. D., Wilujeng, I., Prasetyo, Z. K., & Triyanto. (2019). Building an indigenous learning community through lesson study: challenges of secondary school science teachers. *International Journal of Science Education*, *41*(3), 281–296. https://doi.org/10.1080/09500693.2018.1548789

Helmi, M., Nurhasanah, & Santoso, B. (2016). Analisa Pengaruh Pemasangan Cadik Pada Kapal Nelayan 3 GT Ditinjau Dari Power Engine. *KAPAL*, 13(2), 78-83. https://doi.org/10.14710/kpl.v13i2.11492

Ilyas, I., & Liu, A. N. A. M. (2020). The Effect of Based E-learning Contextual Approach on Student Learning Motivation. *Jurnal Penelitian Pendidikan IPA*, *6*(2), 184. https://doi.org/10.29303/jppipa.v6i2.425

Kadar, A. (2015). Pengelolaan Kemaritiman Menuju Indonesia Sebagai Poros Maritim Dunia. *Jurnal Keamanan Nasional*, 1(3), 427-442. https://doi.org/10.31599/jkn.v1i3.33

Kim, S.-H., Lee, C.-K., & Kim, M.-S. (2020). A study on the characteristics of hull shape parameter of fishing vessel types. *Journal of the Korean Society of Fisheries Technology*, *56*(2), 163–171. https://doi.org/10.3796/ksfot.2020.56.2.163

Makhmudah, N.L., Subiki, & Supeno. (2019). Pengembangan Modul Fisika Berbasis Kearifan Lokal Permainan Tradisional Kalimantan Tengah pada Materi Momentum dan Impuls. *Jurnal Pembelajaran Fisika*, 8(3), 181-186. https://doi.org/10.19184/jpf.v8i3.15222

McKinley, E., & Stewart, G. (2012). Out of Place: Indigenous Knowledge in the Science Curriculum. In *Second International Handbook of Science Education, Vol. 24*. https://doi.org/10.1007/978-1-4020-9041-7

Matafi, S.N., Dien, H.V.M & Pangalila, F.P.T. (2015). Simulasi pengaruh trim terhadap stabilitas kapal pukat cincin. *Jurnal Ilmu dan Teknologi Perikanan Tangkap 2 (Edisi Khusus Januari)*. Vol.2: 13-18. https://doi.org/10.35800/jitpt.2.0.2015.6966

Nailah, T. (2018). Pembelajaran Sains Berbasis Kearifan Lokal dalam Upaya Peningkatan Konservasi Lingkungan pada Mahasiswa PGSD di Batik Tulis Ciwaringin Cirebon. *AL IBTIDA: Jurnal Pendidikan Guru MI*, 5(1), 69-82. http://dx.doi.org/10.24235/al.ibtida.snj.v5i1.2603

Oni, R., & Utama, I. K. A.P . (2015). Analisa Pengaruh Bentuk Lambung Axe Bow Pada Kapal High Speed Craft Terhadap Hambatan Total. *Kapal: Jurnal Ilmu Pengetahuan Dan Teknologi Kelautan*, 12(2), 78–87.. https://doi.org/10.14710/kpl.v12i2.8351

Prastowo, A. (2012). Analisa Penggunaan Cadik Dengan Tanpa Cadik Pada Kapal Ikan Caraka Baruna Ditinjau Dari Seakeeping, Surabaya: ITS

Rochyat, I. G., & Sunarto, B. (2020). Kajian Nilai Cadik Di Pesisir Selatan Jawa. *GESTALT*, 2(2), 117-128. https://doi.org/10.33005/gestalt.v2i2.62

Rubiono, G., & Martaviano, B. S. (2020). Reduksi Resiko dan Peningkatan Efisiensi Kerja Kelompok Nelayan Sampan Layar di Desa Alasrejo Kecamatan Wongsorejo Kabupaten Banyuwangi. *Jati Emas (Jurnal Aplikasi Teknik dan Pengabdian Masyarakat)*, 4(2), 55-60. https://doi.org/10.36339/je.v4i2.314

Sahara, L., Nafarudin, N., Fayanto, S., & Tairjanovna, B. A. (2020). Analysis of Improving Students' Physics Conceptual Understanding through Discovery Learning Models Supported by Multi-representation: Measurement Topic. *Indonesian Review of Physics*, *3*(2), 57. https://doi.org/10.12928/irip.v3i2.3064

Saregar, A. (2016). Pembelajaran Pengantar Fisika Kuantum Dengan Memanfaatkan Media Phet Simulation dan LKM Melalui Pendekatan Saintifik: Dampak pada Minat dan Penguasaan Konsep Mahasiswa. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 05(1), 53-60. 7(4), 693-700. https://doi.org/10.24042/jpifalbiruni.v5i1.105.

Stewart, R. H. (1997). Introduction to physical oceanography. *Choice Reviews Online*, *34*(09), 34-5103-34–5103. https://doi.org/10.5860/choice.34-5103

Suhendi, H. Y., Ramdhani, M. A., & Irwansyah, F. S. (2018). Verification Concept of Assesment for Physics Education Student Learning Outcome. *International Journal of Engineering & Technology*, 321-325. https://doi.org/10.14419/ijet.v7i3.21.17181 i

Suwindra, I. P. (2012). Pengembangan Modul Software Multimedia Interaktif Dengan Strategi Pembelajaran Berbasis Masalah Untuk Meningkatkan Pemahaman Konsep Dan Hasil Belajar Fisika Siswa Kelas XII SMA. *Jurnal Pendidikan Indonesia*, 1(1), 13-27. https://doi.org/10.23887/jpi-undiksha.v1i1.4483

Syukri, M., Yanti, D. A., Mahzum, E., & Hamid, A. (2021). Development of a PjBL Model Learning Program Plan based on a STEM Approach to Improve Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *7*(2), 269. https://doi.org/10.29303/jppipa.v7i2.680

Wulandari, F. T. (2019). Karateristik dan Sifat Fisik Bambu Petung (Dendrocalamus asper. Backer) di Kawasan Hutan Kemasyarakatan (HKM) Desa Aik Bual, Provinsi Nusa Tenggara Barat. *Buletin LOUPE*, *15*(01), 44–49. https://doi.org/10.51967/buletinloupe.v15i01.27