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Ethnophysics in the Change of Candle Pillars of the Carmeli Church, Kamariang Congregation

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Abstract: Indonesia is very rich in cultural diversity reflected in various aspects, including the tradition of mutual cooperation in the process of changing the candlestick of the Carmel Church as a form of local wisdom in Kamariang Village, West Seram. The process of changing the candlestick of the Carmel Church can be used as a medium or source of physics learning. This study aims to identify the physics concepts contained in the process of changing the candlestick of the Carmel Church of the Kamariang Congregation. The research method used is qualitative descriptive based on ethnoscience. Data collection was carried out in West Seram Regency, Kamariang Village using observation, interview, and literature review techniques. The data obtained were then analyzed, verified, and reduced, then constructed and interpreted into scientific knowledge. The physics concepts that can be extracted from the process of erecting the candlestick of the Carmel Church are force, effort, energy, simple machines, power, Newton's laws, center of gravity, equilibrium, torque, and pressure. The results of the study indicate that the process of erecting the candlestick of the Carmel Church in Kamariang Village can be interpreted into scientific knowledge and implemented in physics learning.

Keywords: Ethnophysics; Maluku Culture; Physics Learning.

Introduction

Indonesia is the world's largest archipelagic country, with 17,508 islands (Sa'diyah et al., 2021) and home to more than 360 ethnic groups (Farhaeni et al., 2023). Indonesia is a country rich in cultural diversity. One cultural heritage that reflects this richness is its buildings. Traditional buildings not only serve social and cultural functions for the community but also demonstrate the application of various physics concepts, as seen in the roof shape, the choice of building materials, the supporting structure, and the ventilation system designed to create comfort and durability. Physics concepts can be understood from a local cultural perspective, passed down from generation to generation and applied in everyday life (Wijaya et al., 2021). Thus, society has actually practiced physics principles, although not always explained scientifically. For example, the replacement of the candlesticks of the Karmel Church of the Kamariang Congregation.

The replacement of the 100-year-old candlestick of the Carmel Church is a tangible manifestation of local wisdom steeped in cultural and spiritual values in Negeri Kamarian. This replacement is not merely seen as an ordinary construction project, but as a traditional and spiritual ceremony involving all elements of society. In addition to the spiritual aspect, this process also contains a deep customary dimension, where the community asks for protection from ancestors as a symbol of the traditional Negeri. This emphasizes that the construction and maintenance of the church is a shared responsibility rooted in tradition. Furthermore, there is a spirit of mutual cooperation demonstrated by the Negeri Kamariang community (Christian) with the assistance of the Sepa (Muslim) brothers. The close pela gandong relationship creates an atmosphere of meaningful cooperation from cutting the gupasa wood to erecting the church pillar. The replacement of the candlestick of the Carmel Church can be used to introduce physics concepts.



Figure 1. Replacing the Candlestick of the Carmelite Church

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Physics concepts are often integrated into traditional architecture, although not always explicitly stated. The study of ethnophysics, which explores how traditional societies understand and apply physics principles, is relevant here (Sriwahyuni, 2024). Ethnophysics is an effort to reconstruct indigenous knowledge into scientific knowledge (Hadi & Ahied, 2017; WE Rahayu & Sudarmin, 2015). Some also argue that ethnophysics is the indigenous knowledge possessed by a particular ethnic or social group (Pane et al., 2022). The goal of ethnophysics is to explore the relationship between culture, knowledge, and scientific practice, to enhance understanding of how cultural context influences the production and dissemination of scientific knowledge. Local culture-based learning can also foster students' love of regional culture and raise awareness of the importance of preserving local wisdom.

Several studies have shown that integrating local culture into physics learning can deepen understanding of scientific concepts. Research conducted by Hermansyah and Siti Sriyati in 2024 on ethnoscience studies on Sumbawa's "dalam Loka" stilt houses by linking physics concepts found in the architecture of "dalam Loka" stilt houses, including damped forces, properties and types of insulating materials, temperature, heat, Earth's rotation, balance, gravity, pressure, lateral force, Bernoulli's principle, simple machines, density, elasticity, water absorption, and rigid bodies (Hermansyah et al, 2024). In addition, there is also a study by Eliza Arista and Triessa Rezita in 2024 on the relationship between physics concepts and local wisdom in Belitung traditional houses. This traditional house shows the relationship between building structures and physics concepts such as vibrations and waves. This study emphasizes the importance of integrating ethnophysics in learning to enrich students' understanding (E Arista et al, 2024).

The novelty of this research is the integration of physics concepts into the process of changing the candlesticks of the Karamel Church of the Kamariang Congregation. This research on changing the candlesticks of the Caramel Church has never been conducted before, so it can provide a new contribution to local culture-based physics learning. This study aims to identify the physics concepts contained in the process of changing the candle poles of the Kamariang Congregation of the Carmelite Church.

Method

This research uses a descriptive qualitative approach based on ethnophysics and is located in Kamariang Village, West Seram Regency, Maluku Province. The subject focuses on the local wisdom of the community, namely the replacement of the candle pillars of the approximately 100-year-old Carmel Church, to link (identify) them with the concept of physics.

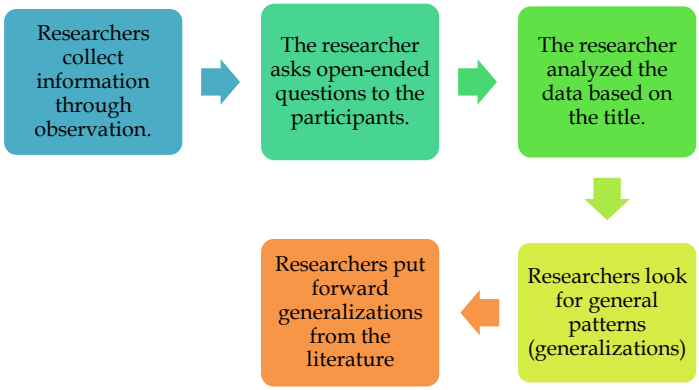


Figure 2. Research Steps

The data obtained consisted of interviews, documentation, and direct field observations. Data collection was conducted through field observations to directly observe the changing of the candlesticks. Researchers also conducted open-ended interviews to elicit the views and opinions of informants. Documentation was also collected during observations as visual data for the study. The data obtained were analyzed manually by reducing, presenting, drawing conclusions, and verifying.

Results and Discussion

The process of replacing the candlesticks (church pillars) at the Carmel Church is a local cultural heritage rich in meaning and involves the entire Kamarian and Pela Sepa community. This collaborative activity is a highly effective learning tool for understanding various physics concepts. The following are activities related to the Carmel Church candlestick replacement process:

Cutting Gupasa wood (with Chain saw/Senso).

Cutting gupasa wood involves physics concepts such as force, work, energy, friction, pressure, and simple machines. During the cutting process, the applied force produces work and converts energy to separate the wood fibers until the wood is cut.

Concept of Style, When wood is cut using a senso, someone applies force to the tool. The magnitude of the force affects how easily the wood can be cut. Efficient cutting is achieved by balancing the weight of the machine, the thrust angle, and the frictional force between the chain and the wood. Force is a vector quantity that has a direction and a point of action, not just a scalar quantity without direction (Fauziah & Nur,

2022; Putra et al., 2022; Sari et al., 2021; Hanifah et al., 2023). The Concept of Work, When force is used to move the senso so that it cuts wood, work occurs. The greater the force or the further the senso moves, the greater the work done.



Figure 2. Gupasa Wood Cutting

The Concept of Energy, Wood cutting converts chemical energy from human muscles or electrical energy from the cutting machine into mechanical energy used to cut the wood. Some energy is also converted into; 1) Heat energy due to friction, and 2) Sound energy when the wood is cut. The Concept of Friction, Friction occurs between the cutting machine blade and the wood surface. Friction helps the cutting process, but if it is too great it can cause; 1) The senso blade heats up quickly, and 2) Energy is wasted as heat. As the chain rotates, friction occurs between the cutting teeth, chain links, and guide bars with the wood fibers. This friction converts kinetic energy into heat energy. If friction is too high, the chain links will quickly become blunt and the blade can bend or expand. Simple Machine Concept, Wood cutting using a senso applies a combination of several simple machines to multiply the force and make it easier to cut hard wood fibers. One application of a simple machine in a senso is an inclined plane, where the senso chain links (cutting teeth) are designed in the shape of a wedge or a small, inclined ship. The senso teeth utilize the principle of an inclined plane to split the wood fibers micro. The function of this inclined plane itself is to convert the thrust force in the direction of the chain into a perpendicular splitting force to tear the wood structure.

Logging (from the forest to the main road)

Pulling wood from the forest to the main road applies the concepts of tensile force, friction, effort, energy, power, and Newton's laws. The most influential factors in this process are usually the mass of the wood and the friction between the wood and the ground, as both determine the amount of force required to move the wood.



Figure 3. Wood Pulling

The Concept of Pull Force, When wood is pulled by humans, animals, or vehicles, a force is applied to move the wood from one place to another. The greater the mass of the wood, the greater the force required to pull it. The Concept of Friction Force, Friction occurs between the wood and the ground surface. Frictional force inhibits the movement of the wood so that the puller must apply a greater force. The coefficient of friction varies depending on wet, dry, or slippery ground conditions. Frictional force can occur on objects with smooth or rough surfaces. The smoother the surface of the object, the smaller the frictional force. Conversely, the rougher the surface of the object, the greater the frictional force (Hardiansyah, 2021). Frictional force is always opposite to the direction of motion, although the conditions are not always so (Mulyaningsih et al., 2024; Utamy & Rosdiana, 2023; Wahyudi et al., 2020; Lestari et al., 2024). The Concept of Work, When force is used to move wood a certain distance, work occurs. The further the wood is pulled, the greater the work done. In addition, the force applied must exceed the frictional force of the soil. If the ground surface is muddy or rocky (high coefficient of friction), the force required automatically increases, so the effort expended is also large. Scientifically, work only occurs if there is a displacement in the same direction as the force (Rahmadani et al., 2023; Mak et al., 2022; Misbah et al., 2020; Ningrum et al., 2022; Rosita et al., 2021; Subekti et al., 2023; Fathurrahman et al., 2024). Energy Concept,

Pulling wood involves energy changes, including; 1) Chemical energy from food in humans or animals into mechanical energy, and 2) Some energy is converted into heat due to friction. Newton's Law Concept,According to Newton's First Law (Inertia): A piece of wood at rest will remain at rest until a force acts on it. According to Newton's Second Law: The acceleration of the wood depends on the magnitude of the pulling force and the mass of the wood. According to Newton's Third Law: When the rope pulls on the wood, the wood exerts an equal and opposite reaction force on the rope. The Concept of Power,If the wood is pulled quickly, more power is required, so the main factors that determine the power requirements include; 1) The speed of pulling the wood, and 2) The maximum load.

Mutual cooperation carrying wood

In the mutual cooperation activity of carrying wood, there are physical concepts in the form of force, weight, balance, work, energy, pressure and center of gravity. The bearers work together to share the load so that the force borne by each person is smaller. During moving wood, body energy is converted into movement energy to do work.



Figure 4. Working together to carry wood

Concept of Style,Each person carrying the wood exerts an upward force to hold the weight of the wood so that it does not fall. The greater the mass of wood, the greater the force the bearers must bear. Burden Sharing Concept: In mutual cooperation, the weight of the wood is shared among several people. If many people carry wood in a relatively balanced position, then the force borne by each person will be smaller than if carried by just one person. The concept of balance of forces, when wood is carried stably and does not move up or down, the upward force of the bearers is equal to the downward force of the weight of the wood. This condition shows that the wood is in a state of equilibrium. Concept of Center of Weight and Balance of Objects, So that the wood does not tilt or fall, the bearers must position themselves in such a way that the center of gravity of the wood remains balanced. If one side bears a greater load, the wood will tend to tilt. Business Concept, When wood is moved from one place to another, the bearers do work because it exerts a force while moving. Chemical energy from the body (food products) is converted into mechanical energy to move wood. Concept of Pressure on the Shoulders, Wood exerts a compressive force on the shoulders of the bearers. The amount of pressure depends on the weight of the wood and the contact area between the wood and the shoulder. Therefore, padding or fabric is usually used to increase the contact area and reduce pressure on the shoulder.

Erecting a candle pillar

The activity of erecting the candlestick of the Carmel Church applies physics concepts such as force, weight, torque, center of gravity, rigid body equilibrium, effort, and gravitational potential energy. The most prominent concepts are torque and equilibrium, as the pole must be rotated from a lying position to an upright position and then held steady.



Figure 5. Erecting a Candlestick

*Concept of Style*When the pole is lifted from a horizontal position to an upright position, the worker applies force to change the position of the pole. The greater the mass of the pole, the greater the force required.*The Concept of Weight*, The candle pole has a weight that always works downwards due to the influence of gravity.*The concept of Moment of Force (Torque),*When a pole is erected, it rotates about a pivot point at the base of the pole. The farther the force is from the pivot point, the easier it is to erect. The cause of this rotation is called the moment of force. The moment of

force is the cross product of the distance vector and the force vector (Purwoko and Fendi, 2020).*Concept of Center of Gravity,*During the erection process, the position of the center of gravity of the pole changes relative to the support point. The pole will be more stable when its center of gravity is directly above the base of the support.*The Concept of Equilibrium of Rigid Objects,*After the pole is standing upright, the pole must be in a state of equilibrium, meaning there is no resultant force or resultant torque that causes the pole to move or collapse.*Concept of Work and Energy,*When a candlestick is lifted from a low position to an upright position, work is done, increasing gravitational potential energy. Work and energy are closely related, as work is a change in energy (Abdullah, 2017). Energy is an abstract concept often defined as "the ability to do work." Energy only changes form into heat due to friction (Sari & Hidayat, 2021; Ismail et al., 2023).

The connection between physics concepts and the process of erecting a candlestick at the Carmel Church in Kamariang Village demonstrates that physics learning can be integrated into local contexts, where teachers can use examples and phenomena from local cultures to explain physics concepts. Contextual-based teaching materials that integrate local wisdom enhance understanding of physics concepts (Sae et al., 2021; Satriawan & Rosmiati, 2017). The relevance and connection of physics concepts to practices and phenomena familiar to students in everyday life make learning more relevant and meaningful. Contextual learning makes it easier to connect physics material considered difficult with their culture and environment.Local wisdom-based learning creates interactions between educators and students, giving meaning to what is seen, heard, read, and learned from cultural heritage, thereby developing students' potential for rational thinking (Landiana, 2019). The elaboration of traditional knowledge in the science curriculum has strong implications for students (Handayani, 2018). Learning that is based on local wisdom and involves traditions existing in the students' neighborhood will provide a contextual impression (Bakhtiar, 2016).

Conclusion

Based on the research results, it was found that the establishment of the candle pillar of the Carmel church in Kamariang Village is one of the cultural heritages or local wisdom that is still owned by the Kamariang community until now which can be studied and analyzed from its physics concepts so that it can be a source of learning for students or university students. The physics concepts contained in the establishment of the candle pillar of the Carmel church include force, effort, energy, simple machines, power, Newton's laws, center of gravity, equilibrium, torque, and pressure. Physics lecturers and teachers are expected to be able to link the local wisdom of the area where they teach with the physics concepts taught so that learning feels meaningful, conscious, and enjoyable. For further researchers, they can study more deeply the relationship between this local wisdom and the material taught in junior high and high school (application to physics learning).

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the authors declare no conflict of interest

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