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Identification of Physics Concepts in Tanjung Batu *Knock Down* House

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Abstract: *This research aims to identify the physics concepts present in various components of knock-down houses. Data collection was conducted through interviews, observations, and documentation. The research took place in the village of Tanjung Batu, Ogan Ilir Regency, South Sumatra. The method employed in this study was qualitative research with a descriptive explanatory form. The findings indicate that there are physics principles in several components of knock-down houses. These include the equilibrium of rigid bodies, evident in the stairs and supporting pillars of the house, the concept of torque that occurs when opening and closing windows, the concept of the center of gravity acting on the roof of the house, electrical concepts present in house lights, and the concepts of temperature and heat influenced by the house's materials. Additionally, the concept of measurement is evident in the lengths of the wooden beams used in the construction of the knock-down house. Based on the results of this research, it can be concluded that knock-down houses represent local wisdom that incorporates physics concepts suitable for educational purposes.*

Keywords: *Local wisdom, physics concepts, knock down houses*

Identifikasi Konsep Fisika pada Rumah *Knock Down* Tanjung Batu

Abstrak: Penelitian ini bertujuan untuk mengidentifikasi adanya konsep-konsep fisika yang ada pada setiap bagian-bagian rumah *knock down*. Pengumpulan data dilakukan melalui wawancara, observasi, dan dokumentasi. Adapun lokasi penelitian dilakukan di desa Tanjung Batu, Kabupaten Ogan Ilir, Sumatera Selatan. Metode yang digunakan dalam penelitian ini adalah metode kualitatif dengan bentuk eksplanasi deskriptif. Hasil penelitian menunjukkan bahwa terdapat prinsip fisika pada beberapa komponen rumah *knock down* diantaranya yaitu kesetimbangan benda tegar yang dapat dilihat pada tangga dan tiang penyangga rumah, konsep momen gaya yang terjadi ketika membuka dan menutup jendela, konsep titik berat yang bekerja pada atap rumah, konsep kelistrikan yang ada pada lampu rumah serta konsep suhu dan kalor yang dipengaruhi oleh material rumah dan konsep pengukuran pada setiap panjang balok-balok kayu yang rumah *knock down* pada saat pembangunan rumah tersebut. Berdasarkan hasil penelitian ini dapat disimpulkan bahwa rumah *knock down* merupakan salah satu kearifan lokal yang memuat konsep-konsep fisika yang dapat dijadikan pembelajaran.

Kata kunci: Kearifan lokal**,** konsep fisika, rumah *knock down*

INTRODUCTION

Indonesia's uniqueness is reflected in the diversity of tribes, languages, customs, and cultures that make up its distinctive identity. Indonesia is known as a country rich in diversity of tribes, languages, customs, and cultures (Albantani & Madkur, 2018). However, in this modern era there has been a shift in the interest of the younger generation who are more interested in foreign cultures. In fact, Indonesian people are more likely to like foreign cultures that are considered more attractive. This has led to the fading of local culture due to the lack of interest from the younger generation who learn and inherit the local culture. Referring to this, Sham, (2015) stated that foreign cultures are now widely spread through social media, films, music, and global lifestyles. The increasing prevalence of foreign cultures that continue to enter will certainly be able to erode and dilute the heritage of local wisdom owned by the Indonesian nation, for this reason, it is necessary to learn local culture-based science to overcome these problems so that Indonesian culture can continue to exist in its authenticity even though it is buffeted by globalization (Nahak, 2019). With the learning of science based on local wisdom, Indonesian culture can still have strong authenticity and sustainability in the midst of increasingly open globalization. Thus, aspects of local culture can be maintained and accommodated in the evolving global dynamics.

Local wisdom can be interpreted as the interrelation between nature, humans, and the environment (Susiati et al., 2020). Local wisdom contains values that can be reflected in the learning process of science. Integrating local wisdom in the context of science is a step to create teaching that is appropriate to the situation and provides appreciation for the culture and values upheld in the area (Rahmatih,A., 2020). This is in line with the view of (Wiyono et al., 2020) which states that by aligning the learning process with local wisdom, it will indirectly increase students' awareness of local identity and cultural heritage. Therefore, education based on local wisdom will be able to provide character values and the importance of protecting the environment to students.

Local wisdom is also influenced by customs and culture in a particular area. One form of local wisdom is a house or building in each area that still maintains building elements or characteristics of the architecture of the house or building (Susiati et al., 2020). One of the houses that still retains the characteristic elements of the area is the knock down house. A knock down house is a type of traditional house typical of Ogan Ilir that can be disassembled and moved from one location to another without causing damage to the overall structure. The structure of the house uses a method of arranging interlocking component parts by not using glue at all in the connections between the components (Riyandi & Miswati, 2021).Meanwhile, according to (Syarifuddin et al., 2022) a knock down house is a house whose shape imitates and modifies the Palembang Limas house. The house includes stilt houses that have social and cultural values of the local community designed based on aspects of safety and comfort for its residents. For example, in the use of materials that use wood-based materials in order to withstand natural disasters and extreme weather.

The traditional house originating from Tanjung Batu, Ogan ilir not only has the values of local wisdom but also physical concepts. But few realize that the house can be used as a source of physics learning. Therefore, the formulation of the problem underlying the writing of this paper is What are the physics concepts contained in the knock down house in Tanjung Batu, Ogan Ilir?" In an effort to answer this question, the main purpose of writing this paper is to identify and explore physics concepts that exist in knock down houses in the area.

RESEARCH METHODS

The type of research used is qualitative research using an analytical approach on knock down houses. The objects studied are physical concepts in knock down houses. This research will be carried out in October-November 2023 in Tanjung Batu Village, Ogan Ilir Regency, South Sumatra. This village was chosen as the location of the study because Tanjung Batu village is the center village for making knock down houses where the majority of the population works as carpenters who have special skills in making knock down houses. Data in this study was collected through observation, interview, and documentation methods.

RESULTS AND DISCUSSION

Tanjung Batu is a village located in Ogan Ilir Regency, South Sumatra. This village is known as a center of wood crafts, especially in the manufacture of knock down houses. Therefore, most of the people there work as wood craftsmen. The large number of wood craftsmen there is due to the tradition of the community who passed on their skills for generations. According to (Syarifuddin et al., 2022) The history of the demolition house in Tanjung Batu is closely related to the legend of Usang Sungging. Usang Sungging is a wood expert who is famous for his expertise in processing wood without causing damage or fractures to the wood. This legend describes how knowledge and skills in wood construction have been passed down from generation to generation, creating a tradition of house-building that continues today.

A knock down house is a type of traditional house that can be assembled and disassembled as needed. This wooden house was built using quality materials such as Meranti wood, Seru wood and Rasau wood. The size of these knock down houses varies depending on consumer demand. The sizes that are usually sold are 4x4 m, 6x6 m, 5x7 m, 6x8 m, 6x12 m, and 8x12 m at a price of 45-200 million according to the sizes, the larger the size of the house, the higher the price of the house. Beautiful carvings, quality wood, and very neat paintings are unique for the house (Syarifuddin et al., 2022) Knock down houses include a type of stilt house that reflects the local wisdom of the community and offers the concept of safety and comfort. The concept of safety includes the use of materials that are resistant to natural disasters or extreme weather that may occur in the region. In addition, the design of the house on stilts provides distance between the house and the ground level, thereby reducing the risk of flooding and attacks by wild animals (Rahayu & Harris, 2017).

1. Moment of force on the window

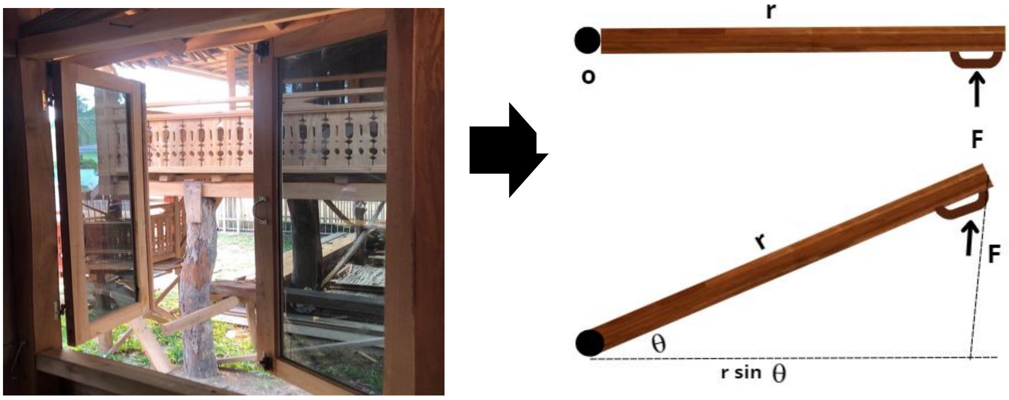

Figure 1. Knock down house windows and window illustrations

The moment of force is the amount of force acting on an object that can cause the object to rotate (Atmaja et al., 2019). The moment of style is found in the knock down window of the house, which is when the window is opened. The picture of the knock down house window above shows that the window has several parts, namely point o as a hinge (axis), r is the width of the window (force arm), and at the end there is a handle that we can use to push the window when opening it which we symbolize with F as a form of force that we give when pushing the window. The moment of force on the window is due to the presence of hinges. This is supported by (Suma et al., 2022) in his book which states that windows have a shaft that can be rotated so as to cause rotation. So, the moment of force will only

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occur on objects that rotate not only windows but also doors. In addition to the shaft as a condition that the object has a moment of force, there are other quantities that affect the moment of force. Mathematically it can be written as follows.

$$\vec{T} = \vec{F}.\vec{r}\sin\theta \tag{1}$$

The equation of the moment of force $\vec{T} = \vec{F}\,.\,\vec{r}\sin\theta$ describes the relationship between force ($\vec{F}$), distance from axis of rotation ($\vec{r}$), and angle between force and distance (θ) in the context of physics. The force applied to an object will create a moment of force that tends to make the object rotate on its axis. If the force is applied perpendicular to the distance, then the maximum moment of force will occur. The force arm on the window exerts a large influence on the magnitude of the resulting moment of force. in the context of the window,The greater the distance between the window handle and its axis, the greater the moment of force generated by the force applied to the handle. By understanding this concept, we know how to minimize the force required to open the window.

2. Equilibrium on stairs

The steps are generally an odd number and the angle formed by each step is equal to the angle of inclination of the stairs. This is supported by (Afrizon & Dwiridal, 2017) which states that the angle of the angle on each step will be the same as the angle of inclination of the stairs. Stairs in knock down houses are also always in an odd number, this is because the odd number of stairs allows for one step in the center of the stairs. This central rung helps in the distribution of the load evenly throughout the stairs. By having a central staircase, the load of the ladder user can be spread efficiently, reducing the possibility of structural imbalances. Referring to this (Arsyi et al., 2021) states that odd numbers are related to the center of mass in the concept of equilibrium. According to (Zulkarnain & Hildayanti, 2018) the ideal staircase tilt angle is to range from 30 to 40 degrees. It can be concluded that the slope angle of the stairs between 30 to 40 degrees is ideal because it relates to the concept of equilibrium. The concept of equilibrium on knock down stairs can be seen in Figure 2.

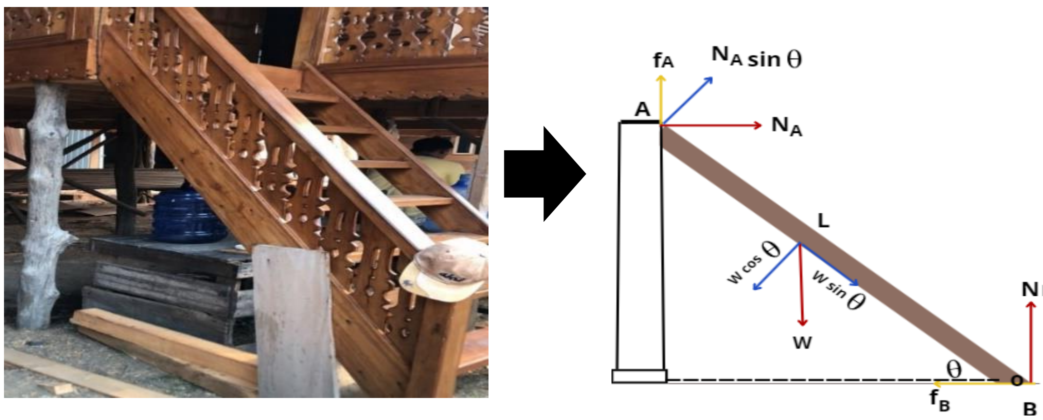

Figure 2. Knock down house stairs and illustration of physics concepts on stairs

Figure 2 above shows the stairs in the knock down house and illustrations of stairs with the amount of physics that work on the stairs. Mathematically, the conditions for rotational equilibrium and translational equilibrium that occur on stairs can be written as follows.

$\sum \tau = 0 \ \rightarrow \text{(rotational motion)}$ (2)
$\sum F = 0 \ \rightarrow \text{(translational motion)}$ (3)

When, Στ=0,

$$f_A . L\cos\theta + N_A\, L\sin\theta - W\frac{1}{2}\, L\cos\theta = 0 \quad (4)$$

$$W_A\, L\sin\theta = \frac{1}{2}\, W\, L\cos\theta - f_A\, L\cos\theta \quad (5)$$

$$\frac{Sin\,\theta}{cos\,\theta} = \frac{\frac{1}{2}W - f_A}{N_A} \quad (6)$$

$$\tan\theta = \frac{\frac{1}{2}W - \mu_D . N_A}{N_A} \quad (7)$$

$$N_A \tan\theta = \frac{1}{2}\, W - \ \mu_D . N_A \quad (8)$$

$$N_A = \frac{\frac{1}{2}W}{\tan\theta + \mu_D} \quad (9)$$

When, ΣF_y=0,

$$N_B + f_A - W = 0 \quad (10)$$

$$N_B + \mu_D . N_A - W = 0 \quad (11)$$

$$N_B + \ \mu_D . \frac{\frac{1}{2}W}{\tan\theta + \mu_D} = W \quad (12)$$

$$N_B = W - \mu_D . \frac{\frac{1}{2}W}{\tan\theta + \mu_D} \quad (13)$$

When, ΣF_x=0,

$$N_A - f_B = 0 \quad (14)$$

$$N_A - f_B = 0 \quad (15)$$

$$N_A = f_B \quad (16)$$

$$\frac{\frac{1}{2}W}{\tan\theta + \mu_B} = \ \mu_L . N_B \quad (17)$$

$$\frac{\frac{1}{2}W}{\tan\theta + \mu_B} = \ \mu_L . \left(W - \frac{\mu_D . \frac{1}{2}W}{\tan\theta + \mu_D} \right) \quad (18)$$

$$\frac{1}{2\tan\theta + 2\mu_D} + \frac{\mu_L . \mu_D}{2\tan\theta + 2\,\mu_D} = \ \mu_L \quad (19)$$

A balanced object must meet the equilibrium condition, which is $\sum \vec{F} = 0$ or ∑Fx = 0; ∑Fy = 0; ∑Fz = 0 and $\sum \vec{\tau} = 0$. In translational equilibrium, the sum of all forces acting on the ladder in the horizontal direction (ΣFx), vertical direction (ΣFy), and perpendicular direction of the plane (ΣFz) must be zero. This means that the forces pushing the stairs sideways, up, and down must be balanced so that the stairs do not experience unwanted translational movement.In rotational balance, the sum of all moments of force acting on the ladder against the axis of rotation must be zero. This means that the moment of force generated by the forces acting on the ladder must be balanced so that the ladder does not experience unwanted rotational movements. The application of the concept of equilibrium of rigid bodies on stairs is clearly seen when a person walks on the stairs. The weight of the person will exert a downward force on the stairs. To maintain balance, the frictional forces between the stairs and the wall must be large enough to balance the gravity. In addition, the moment of force generated by the weight of the person must be balanced with the moment of force generated by other forces acting on the ladder.

3. Equilibrium and Center of Gravity of Knock Down Roofs

Equilibrium is divided into two types, namely static equilibrium (balance of objects when at rest) and dynamic equilibrium (balance of objects when moving at a constant speed) (Sholihah et al., 2023). The equilibrium that occurs in the knock down house is static equilibrium. Where the roof of the house in the knock down house is stationary so that if the wooden bars that make up the roof of the house are stationary, then the log applies translational equilibrium and rotation. The front roof of the knock down house and its physics concept is illustrated in Figure 3.

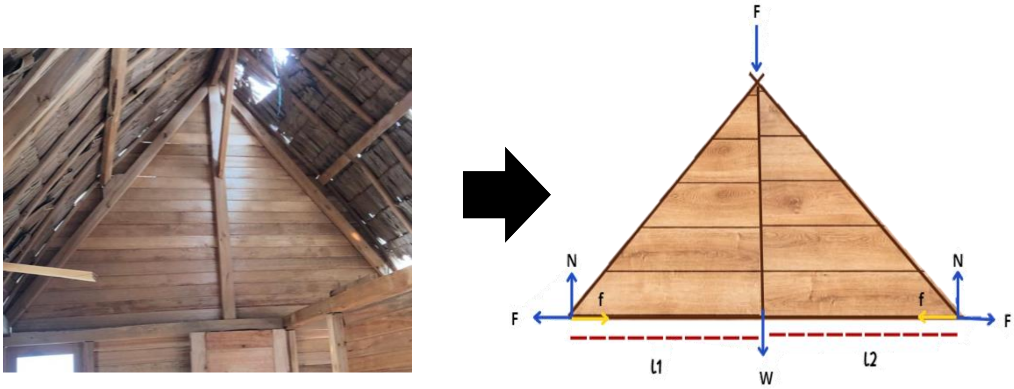

Figure 3. The front roof of the knock down house and illustration of its physics concept

In the picture above is shown the front roof of the knock down house where if we analyze there are several forces that work both on the x axis and the y axis mathematically can be written as follows.

$$\sum Fy = N - F + W \quad (20)$$

$$\sum Fy = N - F + m.g \quad (21)$$

$$\sum Fx = f - F \quad (22)$$

$$\sum Fx = \mu s - F \quad (23)$$

On the roof of a knock down house made of wood with an equilateral triangle shape on the front, there is a concept of emphasis that has implications for the stability and balance of the building structure. The weight point is the point at which the entire mass of the object is considered centered and changes in the position of the weight point can affect the equilibrium condition of an object (Mulyaningsih et al., 2023). For more details see Figure 4.

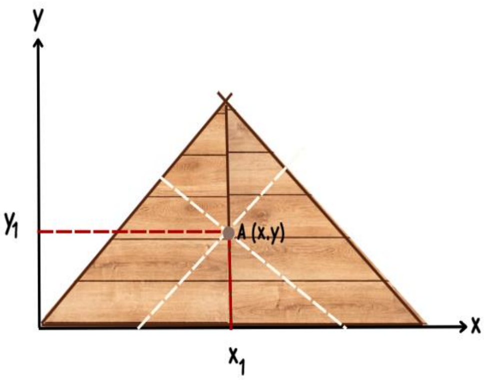

Figure 4. Illustration center of gravity on the Roof

$$\bar{x} = \frac{A_1x_1+A_2x_2+A_3x_3+\cdots}{A_1+A_2+A_3+\cdots} = \frac{\sum_{i=1}^{n} A_ix_i}{\sum_{i=1}^{n} A_i} \quad (24)$$

$$\bar{y} = \frac{A_1y_1+A_2y_2+A_3y_3+\cdots}{A_1+A_2+A_3+\cdots} = \frac{\sum_{i=1}^{n} A_iy_i}{\sum_{i=1}^{n} A_i} \quad (25)$$

In the context of a knock down house, the determination of the weight point uses a mathematical formula involving the x and y coordinates. A is the area of the component parts of the knock down house, while x and y are the coordinates of these points with respect to the x and y axes. Summation is done for all parts of the knock down house components to the total mass of the building.Using this formula, we can calculate the exact coordinates of the heavy point.

4. Electricity

The concept of electrical physics is very close to everyday life. Electricity that we usually encounter, especially in knock down houses, not only functions as lighting but can also be used as a learning study on physics material, namely the concept of electricity as seen in Figure 5.

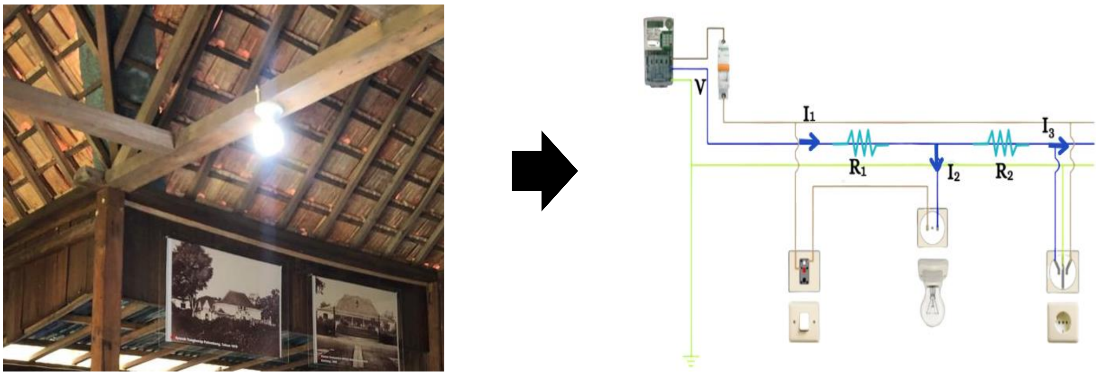

Figure 5. Knock down house lights and physics illustrations

Lights in knock down houses are one of the applications of physics in everyday life. Basically, lamps use electrical energy to produce light and this phenomenon can be explained by the concept of physics. The physics concept in question is the concept of electricity. When electricity flows through a lamp, it passes through the resistive wire inside. Resistors in lamp wires create resistance to the flow of electric current. As electricity flows through the resistor, it generates heat that can cause the wire to emit light. This is in line with the view (Suryanto & Bakhri, 2022) which states that if electric current flows through an obstacle, the resistance is heated, this indicates the conversion of energy from electricity to thermal energy.

Electric current according to (Serway, 2004) comes from the consistent movement of electrons from the negative pole to the positive pole in a closed conductor. In general, current moves from the positive pole with high potential to the negative pole with low potential. Two conditions with a potential difference can produce electricity, provided that they are connected through a conductor. This theory is in accordance with the application of electricity in knock down houses where the electric current that flows from one point to another is connected to a closed conductor in the form of a cable. Electrical energy contained in a resistance or in a large electric voltage can be known through the following equation (26).

$$W = V.I.t \ = I^2.R.t \tag{26}$$

Power on resistance is,
with ohm's law V= I.R then

$$P = \frac{\Delta Q}{\Delta t} = I.V \tag{27}$$

$$P = I^2.R \tag{28}$$

Electrical energy stored in a large electrical resistance or voltage can be measured using equation 26. This means that when we use electrical devices such as knock down house lights, the electrical energy used by those lights can be calculated by paying attention to voltage (V), current (I), and usage time (t).In addition, the concept of power (p) on an obstacle is also important in knock down houses. By understanding the power required by each electronic device in a knock down home, we can choose devices that are more energy efficient, thus saving electricity costs and supporting environmental sustainability. The concept of power and electrical energy itself has a relationship with each other which can be explained through the formula $P = \frac{W}{t}$ which means The greater the power of a device, the faster the electrical energy used during a certain time.

5. Temperature and Heat

Temperature and heat in knock down houses have an important role in comfort and energy efficiency. The right temperature can create a comfortable environment for its occupants, while good heat management can help reduce energy consumption. To better understand this concept, consider Figure 6.

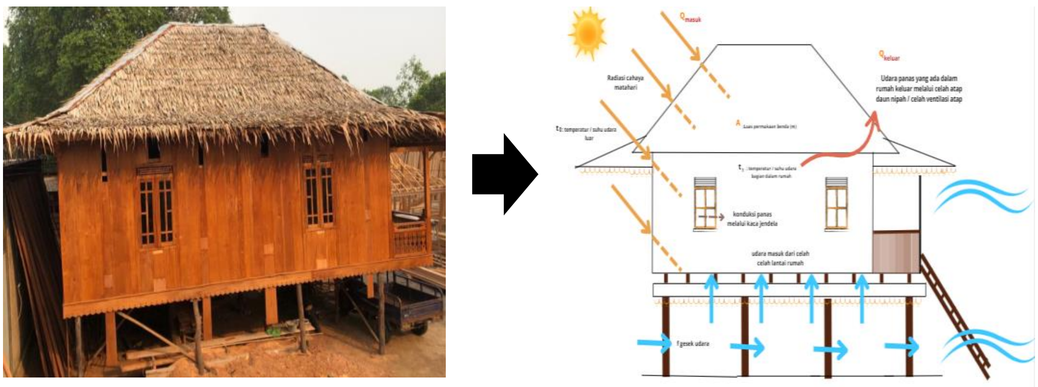

Figure 6. The process of temperature and heat in knock down houses

Solar radiation is the largest contributor to the amount of heat entering a building. The solar radiation that falls on the building envelope is reflected back and partially absorbed. The absorbed heat will be collected and forwarded to the cold side (the inside of the building) (Rizal & Demami, 2022). The application of the concept can be seen in Figure 6. In Figure 6 above, sunlight radiation is the main factor in heat transfer in knockdown houses. When sunlight shines on the roof and walls of the knock down house, heat energy will be absorbed. Some of the heat is then emitted back into the room, creating warm conditions. According to (Yani et al., 2018) heat enters the building through the conduction process in building materials, especially through the roof. This is clarified by (Latifah et al., 2013) who said that heat enters the building through the process of conduction (through walls, roofs, glass windows) and solar radiation transmitted through windows / glass. The hot air formed in the knock down house room will then rise upwards out through the cracks in the roof vents while the air coming from the lower floor will replace its position. Then, the remaining hot air that is still in the room will come out through the window and door vents. The conduction heat transfer in the knock down house can be determined by the following formula.

$$q = k.A.\frac{\Delta T}{\Delta x} \qquad (29)$$

Equation (29) describes the phenomenon of conduction heat transfer in the material in a knock down house. The basic principles of conduction heat transfer are that heat flows from areas with high temperatures to areas with low temperatures through direct contact between particles in the material. Thermal conductivity k expresses how well the material conducts heat, while the cross-sectional area A and temperature difference of ΔT affect the magnitude of the heat transfer rate. The distance of Δx is also an important factor, because the farther the distance, the slower the rate of heat transfer. In its application, knock down house materials such as knock down roofs that use nipah leaves are materials that are not good at conducting heat so that the solar heat delivered will not be as hot and fast as when the roof uses zinc or aluminum material. In addition, the structure of the knockdown house is arranged with many vents so that the heat that is blown in can come out of the ventilation gaps of the walls on the roof or under the floor so that air from inside comes out and outside air can enter to make the indoor temperature cooler and more comfortable.

6. Measurement

The use of tools to measure wood in the context of knock down houses requires an understanding of the physical concepts of precise measurement. Accurate measurements are essential in ensuring the precision and accuracy of wood pieces used in home construction. The use of wood measuring instruments in making knock down houses can be seen in Figure 7.

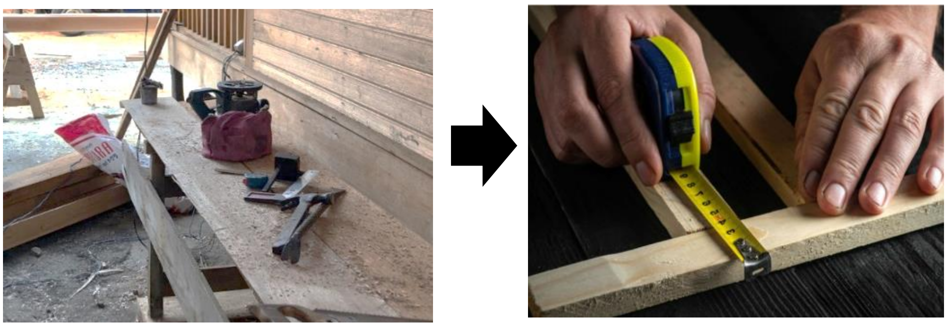

Figure 7. Equipment used when cutting wood in the manufacture of knock down houses.

Measurement is the act of determining the quantitative value of an object systematically (Nasution, 2019). Knock down houses are made by applying one of the physics concepts, namely measurement. The length of wood needed certainly needs to be measured first with the right measuring instrument. A tape meter and an elbow ruler are two common tools used, with both relying on the concept of length physics. A tape meter, for example, applies Hooke's law to measure length by utilizing a spring that stretches when pulled. The equation can be explained as follows.

$$F = k.x \qquad (30)$$

$$m.g = k.x \quad (31)$$
$$k = \frac{F}{\Delta x} = \frac{m.\ g}{\Delta x} \quad (32)$$

Based on equations 30 and 31 the physics of measurement concepts for example in measuring instruments, rulers, elbows, and tape meters. In this case, the physical concepts involved are the concepts of spring elasticity and the force exerted on the spring when measuring instruments are used to measure the length of wood. The amount of force (F) exerted on a spring will be proportional to the change in length (x) of the spring, as described in equation (30). The spring constant (k) indicates how much the spring will stretch when force is applied, which also affects the accuracy of measuring the length of the wood.

CONCLUSION

Based on research, it can be concluded that there are physics concepts in knock down houses. The physics concepts in knock down houses include the moment of force when opening windows and doors, equilibrium on stairs, emphasis on the roof of the knock down house, electrical concepts applied to house lights, temperature and heat transfer in knock down house rooms, and measurement concepts in the process of making knock down houses.

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