Science and culture centre concept with energy-saving architecture approach

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Abstract. Science and Culture Center is a place that become a center of educational activities, development of science and technologies, and also a meeting place, an interacting place, and a place for cultural exchange between communities. The problem raised in solving design problems is the lack of special designs that meet the needs of design objects in terms of learning and developing culture and science. The main purposes is as a forum for the local community to meet the needs of the center of non-formal educational activities and culture that can be a place for people to gather, move, learning science and culture. In this study, qualitative methods were used in literature studies and comparative study of similar objects involving technical factors and building requirements. Field observations are also carried out, by directly observing field conditions and collecting data by direct observation and interviews with relevant parties. The problems obtained were further analyzed so as to produce a design concept with the theme of Energy-Saving Architecture, including the use of renewable sources, solar cell power plants, techniques for using plants for roofs, rainfed parks, using gravel compacted for pavement areas, etc. The results in the form of design concepts and applications on the design object as a guide to continue the design of the Center.

1. Introduction

Many people are trapped in globalization trends that tend to be oriented toward the western world so that there is a concern for people who are increasingly forgetting what is their own culture and heritage and prefer western culture and western science and technology [1]. The relationship between science and technology and culture is inseparable and has a mutual relationship with each other [2]. To create a balanced value, a strategy is needed that supports the development of science-technology and cultural values simultaneously.

Science and Culture Center is a forum for the communities to meet the needs of non-formal educational facilities outside the school that can be a place for people to gather, do activities, learn about science and technology but also to dedicate ethnic diversity which is expected to be able to add insight into the culture for local communities and international community.

The concept of green building is one form of global community response to climate change as the use of building energy is dominated by climatic influences, because the energy is often used to counter the heat obtained from direct conduction from heat sources or air infiltration / exfiltration through the building surface which can reach 50-80% of the total energy consumed [3]. This idea promotes that improving the behavior and technology of a building can contribute to reducing global warming. It cannot be denied, excessive use of energy in buildings is one of the dominant contributors to emissions.
According to the results of a study published by the European Commission [4], buildings consume around 40% of the world's primary energy and are relatively higher than transportation (30%) and industry (20%). Not only that, buildings contribute 24% - 33% of CO2 emissions. While most energy use in buildings in big cities is for the use of air conditioning and lighting.

1.1. Energy-efficient Architecture

The concept of green building is currently a topic of much discussion, in addition to increasing public awareness of the importance of preserving nature, this is also to conserve non-renewable natural resources. The government has also issued a policy on saving / conserving energy which is mainly aimed at lighting of buildings, air conditioners, equipment and building equipment that uses electricity [5]. The concept of 'green' can also be applied to reducing energy use (electricity), low energy houses and zero energy buildings by maximizing building envelopes. On the other hand, one must also pay attention is how to utilize solar energy, water, biomass, and also waste processing as renewable energy. The buildings with the concept of green architecture, is a socio-cultural reinterpretation of the community towards nature and the life in which they live [6].

If the building is designed without energy considerations, difficulties will arise later, in terms of overcoming the high operational burden on electricity. To overcome this, the government has endeavored to issue PUPR Ministerial Regulation No. 02/PRT/M/2015, which requires that every new building in Indonesia be implemented in order to apply the principles of green building or green/energy saving buildings [7]. Regulation, economy, energy demand and the environment are directly affected by the "energy efficient" building concept. Definitions are also needed to compare the performance of energy buildings or to assess absolute energy saving.

1.1.1. Energy-efficient Building Criteria

Several aspects of the building during the planning, design and operation of the building need to be considered in order to support the 'energy saving' target when the building is operated [8]. An efficient building must, at a minimum, be above average in all three aspects. When setting minimum energy saving standards, the definition of energy saving based on minimum life cycle costs tends to produce stricter standards and greater energy savings than strategies based on eliminating the most efficient units [9].

There are some criteria for energy-efficient building:

- Buildings are equipped with efficient equipment and materials according to their location and conditions;
- Buildings are equipped with facilities and services according to the intended use of the building;
- Buildings are operated in a way that uses less energy than other similar buildings.

1.1.2. External Environment Aspects Outside the Building

There are eight (8) aspects of the external environment that play a major role in determining the level of comfort and determining the level of energy saving, namely: solar radiation heat (direct and diffuse), environmental temperature, humidity, rainfall, wind speed and direction, air quality, topography, and landscape.

1.1.3. Architectural Aspects of the Building

Important aspects of building architecture are three (3), namely: building orientation, building envelope, OTTV calculation. The other aspects that must be considered, namely mechanical equipment operation aspects, building operations and management aspects; and application of building automation.
2. Methods

This study uses qualitative methods with observation data collection techniques and compares the design concepts of several designs with similar themes and functions. To provide a comfortable environment and use of low energy and low greenhouse gas emissions, energy-efficient buildings employ a combination of passive and active techniques [10]. Passive techniques are concerned with forms and materials in buildings, while active systems are more about the use of machines or systems in order to minimize energy use in buildings. On-site renewable energy processing can be used to further reduce emissions. However, low energy use is still a top priority, as it is the easiest way to reduce greenhouse gas emissions. In addition, the low energy use allows the adoption of renewable energy technologies because it emits less energy needed to meet building needs.

This makes it possible to reach the point where a building produces zero net used greenhouse gas emissions, known as 'zero used carbon'. The use of low-carbon building materials and construction methods can reduce the energy contained in the building.

3. Results and Discussion

3.1. Passive Design

The maximum use of sunlight on the building is by design the orientation of windows and openings in order to get the desired sunlight, but at the same time also to limit the entry of unwanted sunlight. In these buildings, solar energy is used passively to anticipate external climate problems. If the outside air is sweltering when entering this building, the cash feels cool. The use of glass with low emissivity and high efficiency allows the reduction in excess temperature caused by sunlight coming in from the window.

Passive design can use natural ventilation that is driven by wind and stacked to provide cooling in summer without the need for air conditioning. Currently, constructing a 'No Carbon Used' building adds at least 5% to the construction cost depending on the building type and other details. Building projects that achieve 'zero carbon' status at no additional cost are minimal.

This kind of building design strategy in Indonesia can be found especially in old buildings including Silaban's works: Istiqal Mosque and Bank Indonesia; Sujudi's work: The French Embassy in Jakarta and the Central Ministry of National Education Building; and most of the colonial buildings by Dutch architects. Some modern buildings in Jakarta also appear to have been completed with the concept of passive solar energy utilization, such as the S Widjojo Building and Wisma Dharmala Sakti, located on Jalan Jenderal Sudirman, Jakarta [11].

The passive methods that are being applied are Active natual lighting (Figure 1), green roof (Figure 2), site cooling (Figure 3), double facade buildings (Figure 4) and skylight (Figure 5).

![Figure 1. Active Natural Lighting.](image-url)
Figure 2. Green Roof.

Figure 3. Site Cooling

Figure 4. Double Façade.

Figure 5. Skylight
3.2. Active Methods.
Active design is additional, it’s focused on how to utilize nature energy and apply it to the building using the help of technologies. Office of Technology Assessment (OTA) regarding Building Energy Efficiency [12], states that the use of energy in buildings in the future will be driven along with technological developments. Understanding active design is a way of saving energy with the help of technological devices that can control, reduce usage, or produce new energy. The utilization of solar thermal energy is most commonly used in the field, including passive solar energy utilization, solar heating, and cooking using solar power [13]. In active design, passive design strategies must be applied. Without the application of a passive design strategy, the use of energy in buildings will remain high if the level of thermal and visual comfort must be achieved. Using this method, solar energy is converted into solar cell electrical energy, then this electrical energy is used to meet the needs of the building (Figure 6).

![Figure 6. Solar Panel.](image)

4. Conclusion
This research discusses low-energy buildings techniques application to Science and Culture Centre building, which is a part of a green architecture concept. The methods is by using a combination of passive and active engineering methods in order to provide a comfortable environment for energy use and to produce low greenhouse gas emissions. The passive method emphasizes the shape of the building, the materials used, and the lighting, while the active system is more about the use of technology / systems to provide services to the building while still minimizing energy use and also implementing existing passive design strategies. As long as thermal and visual comfort levels are to be achieved in the building, if not implementing a design strategy the amount of energy used in the building will remain high.

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