

# STUDY OF ECO-ARCHITECTURE CONCEPT AT MARINA BAY SANDS HOTEL

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## ABSTRACT

*Eco-architecture is a sustainable concept which in essence prioritizes natural and environmental aspects in an architectural design. In addition, eco-architecture also focuses on the use of natural energy as an alternative energy source to replace fossil energy which produces CO<sub>2</sub> which causes damage to natural ecosystems and causes harm to the living things in it. In this research, Marina Bay Sands Hotel is the object of hotel research that uses the concept of eco-architecture in its design. There is also a discussion on the building's energy operational system in which there are passive systems, hybrid systems, active systems and productive systems as levels in the use of building energy with the aim of providing efficient energy for buildings. The last is about the identification of harmony which includes discussing the configuration of the building mass and the orientation of the building. Based on the analysis carried out with the components previously mentioned, it can be concluded that the application of eco-architecture based on its principles has a significant impact on environmental conditions around the site. This is because these principles are principles that pay attention to environmental conditions during the construction period and after the building is active, which makes the building a sustainable building.*

**Keywords:** *Eco-Architecture, Sustainable, Energy efficient, marina bay sands*

## INTRODUCTION

Based on data from the UK's Met Office, the level of carbon dioxide in the atmosphere in 2020 is 50% higher than the era before the industrial revolution due to man-made emissions. With concentration levels exceeding 417 ppm in some countries and continuing to increase. Special attention needs to be given to environmental conditions that are getting worse due to carbon emissions, one of which is in the design and use of building energy.

This is caused by greenhouse gas emissions that have continued to increase since the beginning of the industrial revolution. This makes the earth's temperature which was originally normal to increase until now which is called global warming. This is because global warming makes the air that was originally cool becomes hotter and continues to increase. In addition, the use of energy in the operation of buildings is the largest contributor to carbon emissions, such as the large use of electricity for lighting and the use of air conditioners which actually

increase the temperature outside the building. Eco-architecture is one of the architectural design concepts which in principle prioritizes the manufacturing process to the use of buildings that pay attention to natural and environmental aspects in order to create a suitable environment for living things, especially humans.

Literally, ecology means the science of the household of living things, which are living things which are their living environment. It seeks to minimize the negative environmental impact of buildings with efficiency and moderation in the use of materials, energy, and broad development of space and ecosystems [1]. Eco-architecture itself is also part of a green concept that seeks to minimize adverse effects on the natural and human environment and produce a better and healthier place to live, which is done by utilizing energy and natural resources efficiently and optimally [2]. Eco-architecture uses a conscious approach to energy and ecological conservation in the design of the built environment. Ecological

architecture is also an architecture that is environmentally sound and utilizes the potential of nature to the maximum that is energy efficient and pays attention to the relationship between humans and buildings and their environment [3]. Understanding of natural processes can try to minimize the negative impact on the natural environment that is getting worse [4].

Eco-architecture itself comes from the word ecology. Ecology comes from the Greek words 'oikos' and 'logos'. Oikos means household or way of living, and logos means science or has a scientific nature. So it can be interpreted that ecology has a definition as the study of the reciprocal relationship between living things and their surrounding environment. The principle of environmentally friendly architecture is a basic development of architectural studies that are in line and in harmony with nature. This means that building planning while maintaining and participating in preserving the natural environment [5]. The ecological approach to architectural design is one of the building design concepts that emphasizes awareness and courage to decide on a building design concept that respects the importance of the sustainability of natural ecosystems. This does not determine what should happen in architecture, because there is no binding characteristic as a standard or standard, but includes harmony between humans and nature.

This sustainable concept is widely used as a reference for the use of design today. This is because of the impact on the surrounding climate which certainly affects the pattern of human life so that it depends on artificial comfort which causes a lot of negative things for the surrounding nature. Eco-architecture mainly minimizes the destructive impact on the environment by integrating itself with processes related to living things. Ecological design helps connect the links between green architecture, sustainable agriculture, ecological engineering, ecological restoration, and other fields. Therefore it is a very important part that has a direct impact on the environment.

This study aims to determine how the impact of the use of the concept of Eco-architecture on

buildings. This of course has advantages and disadvantages to its application. In addition, this also aims to get to know more about the relationship between humans and the environment where the concept of Eco-architecture creates a relationship between humans and nature that can bring the quality of life on earth to be better. The importance of this research is as a complement in carrying out sustainable development that cares about the environment in the future.

## **METHOD**

This research approach uses a descriptive approach, which describes the actual phenomena found at the time of data collection and analysis, after that evaluating the findings in the field. In line with that, the researcher will analyze the implementation of the Eco-architecture concept, namely in the hotel building (Marina Bay Sands Hotel) which is the object of the literature study. The data from the analysis sources here are obtained from literature studies and architectural journals found on the internet.

### **Marina Bay Sands**

- Hotel name : Marina Bay Sands
- Hotel location : 10 Bayfront Ave, Singapore
- Total area : 154938 m<sup>2</sup>
- Architect : Safdie Architects

Marina Bay Sands is an entertainment center located in Marina Bay in Singapore which was developed by Las Vegas Sands. It is an iconic building in Singapore that has a unique structure and environmentally friendly function. Therefore, this building is one of the entertainment centers (hotels, etc.) with the best green building concept in the world.

This research is based on the use of eco-architectural principles which have been summarized into 3 points, namely;

1. Use of environmentally friendly energy
2. Use of sustainable materials
3. Buildings that pay attention to the health aspects of their users

In addition to the use of these principles, there is also an identification of building harmony

which explains the concept of eco-architecture which is applied to mass compositions and also through the orientation of the building.

Eco-architecture has the same principles following the principles of sustainable design which is a general guideline in designing a design. Following are the principles [6]:

1. Low-impact material, namely the use of materials that are non-toxic and produced in an environmentally friendly manner.
2. Energy efficiency, namely the use of products that do not require a large amount of energy.
3. Quality and durability, namely the product has a long service life so that it can reduce maintenance or replacement.
4. Recycle or re-use is a product that uses sustainable use at the end-use or end result.
5. Renewability, ie the materials used are taken from the closest area, made from renewable resources.
6. Healthy, it is hoped that the products made will not have an impact on humans or the surrounding environment.

From the points above, it can be concluded that Low-impact material, quality and durability, Recycle or re-use, and Renewability have in common that there are certain criteria in the use of ecological building materials. Energy efficiency itself has a discussion regarding the use of the building's energy which is renewable and friendly to the environment. while healthy itself is the most important component which includes living things themselves, one of which is humans. The main principles of the points above are:

1. Use of environmentally friendly energi.  
The use of environmentally friendly energy is an aspect of energy use in buildings that does not have a negative impact on the surrounding environment.
2. Use of sustainable materials.  
Sustainable materials are materials that are generally obtained not far from the project site. It can also be a material that has a long service life and can be recycled again
3. Buildings that pay attention to the health of their users.  
In terms of health, there are 3 aspects that are part of building health, namely aspects

of natural ventilation, aspects of natural lighting, and how buildings can reduce pollutants and noise.

In addition to the principles above, there is also an aspect of harmony which identifies the physical building based on the configuration of the building mass and also the orientation of the building which is the physical aspect of the building which is ecological [7].

Eco-architecture in general can be interpreted as creating an environment that consumes less and produces more natural wealth. Architecture cannot avoid actions that damage the environment. Therefore, Eco-architecture can be described as architecture that minimizes damage to the environment. In this case, the need for processing that pays attention to aspects of the climate, material chain, and the service life of building materials. Because the principle and purpose of this Eco-architecture is to produce architectural works that do not conflict with nature and ecosystems on earth that produce harmony between humans and nature. Based on several observations by researchers, ecologically sustainable architecture can be identified in the following ways:

1. Does not deplete the material faster than the regrowth of the material by nature.
2. Optimally use renewable energy.
3. Produce waste that can be used as a source of new materials.

As an environmentally friendly architectural design concept, the application of Eco-architecture in buildings is divided into several levels of operational systems used in building energy use with the following categories [8]:

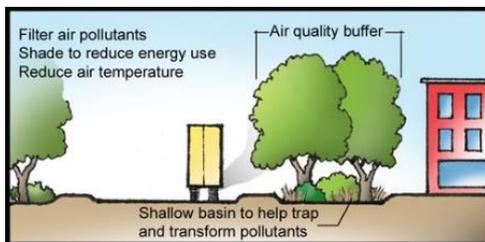
1. Passive system (passive mode)  
The lowest level of energy consumption, with no or minimal use of ME (mechanical-electrical) equipment originating from non-renewable resources
2. Hybrid system (mixed mode)  
Partly dependent on energy (energy independent) or partly assisted by the use of ME.
3. Active system (active mode)  
All use ME equipment sourced from non-renewable energy (energy dependent)
4. Productive system (productive mode)

A system that can generate/generate its own energy (on-site energy) from renewable resources, for example in solar cell systems (photovoltaic) and solar collectors (thermosiphoning).

There are several benefits of vegetation that have a good impact on buildings as follows [9]:

1. Reduce pollutants, produce oxygen, and reduce noise

The parts contained in the plant can reduce noise, dust and disturbing views such as electric poles and various other artificial components. In addition, plants also have physiological functions that enable plants to carry out evapotranspiration and photosynthesis. This process can neutralize carbon dioxide (CO<sub>2</sub>), produce oxygen (O<sub>2</sub>), and increase water vapor levels that cool the surrounding air during the day. In addition, parts of the plant can also reduce noise from around the building.



**Figure 1.** plants that have a role in reducing pollutants and producing oxygen. (source: <https://www.fs.usda.gov>)

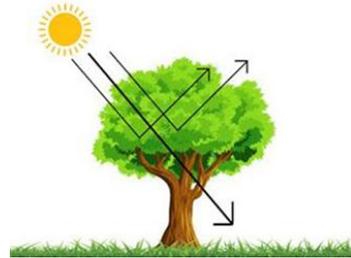
2. Improve climate quality.

Vegetation can function as a component that can absorb the temperature of the sun so as to reduce the solar heat received by the building so that the temperature in the building is not too hot. This effect is caused by the shadows on the plants which also serve to reduce the heat received by the building. In addition, reforestation of plants makes the temperature and surrounding air cooler and cooler because the vegetation is able to remove or reduce solar radiation properly.

3. Solar radiation controller

The vegetation used or selected can also affect the control of solar radiation received by the building. This can be determined from the height of the vegetation to the size of the leaves of the vegetation. dense leafy

plants can reduce light between 51-54% and protect from direct sunlight throughout the day. Shrubs and groundcover (grass cover/soft material) reduce temperature by absorption of radiation and evaporation, and on a hot day, grass can reduce 5.5 – 7.8 °C cooler than open ground.



**Figure 2.** plants can control sunlight so that it reduces radiation from the sun directly.

(source: <https://www.greenpots.com>)

The concept of eco-architecture in hotel buildings is a concept that is the topic of discussion and study in this research. Several hotel buildings that use the concept of Eco-architecture are discussed / literature studies as material for research. This concept was chosen as a topic because this concept can minimize the negative impact on the natural and human environment and produce a better and healthier place to live. The purpose of this ecological design is to design an optimal design and solve problems with an eco-architectural approach that has a building design concept that respects the importance of the sustainability of ecosystems in nature [10]. In addition, the use of local materials as well as the empowerment of existing resources in the environment around the settlement make this residential design able to adhere to environmental and natural conditions [11].

## RESULTS AND DISCUSSION

### Use environmentally friendly energy

In the Marina Bay Sands skypark, there is a 145 KwP solar panel built by Conergy as one of the largest downstream solar companies in the region. The solar panel has an area of 880 sqm of which there are 536 solar panels that can produce 187 megawatts of energy per hour. Based on a project that has been carried out by Conenergy, this solar panel installation is the

highest in the country of Singapore which is at an altitude of 200 m above sea level. Laying solar panels on the highest part of the building can maximize the solar heat received so that it becomes additional energy for the building as an alternative energy source.



**Figure 3.** the location of the solar panels on the highest part of the building.

(source: <https://id.marinabaysands.com>)

The main energy sourced from the country's electricity supply. but with this alternative energy source, it can save the use of energy used by Marina Bay Sands. In addition to energy, this building also saves energy use by the following steps:

- a. Hotel lobby:
  - The glass facade in the hotel lobby allows natural lighting of the room
  - Save electricity usage from artificial lighting
- b. Hotel rooms
  - Indoor sensors will automatically turn off the air conditioner when the balcony door is left open for a long time
  - Just one guest can increase the temperature of the room if no one was in the room before
  - The curtain will automatically close to keep the room temperature low when not in use
- c. Herb garden
  - Fresh herbs grown behind Rise Restaurant
  - Instead of buying outside, Rise Restaurant prefers to use these spices to reduce carbon emissions
  - Information about the spices grown can be seen on the provided board
- d. SkyPark

- Lifts operating to and from the SkyPark recover and convert the generated energy into usable energy; this will save energy.
  - Our eco-friendly roof is able to absorb and reduce the ambient temperature in the SkyPark, and keep it cool.
  - There are a total of 650 plants and 250 trees in the SkyPark.
- e. Shoppes Glass Roof
    - The glass roof above the Shoppes allows natural sunlight to enter the building and illuminate the inside of the building.
    - The light sensor detects the brightness of the sun's rays and instantly adjusts the light in the room; this will reduce the use of artificial light which will save electricity.

These are Marina Bay Sands' efforts to make energy savings more efficient.

### Use of sustainable materials

The materials in this building are modern materials in general which are designed for a long period of time and can withstand the natural conditions of the area. In the process, the materials obtained and used are mostly imported materials from other countries. This is because Singapore is a small country that has limited natural resources.

**Table 1. Durability of Marina Bay Sands building materials.**

No	Material	Recycle	renewability
1	concrete	✓	X
2	granite	✓	X
3	glass	✓	X
4	ceramic	✓	X
5	parquet	✓	✓
6	gypsum	✓	✓
7	iron	✓	X
8	Natural stone	✓	X

(source: personal data)

Some of these materials do have a long service life and are resistant to natural conditions around them, but there are some materials whose quality will decrease over time, one of which is Aluminum composite panels which if

they are often exposed to water and dust particles, the color of the material will change. disappeared over time.

### Building Health Aspects

This building has principles in energy saving, one of which is minimizing the use of artificial light and maximizing the use of sunlight. Therefore, it can have a good impact on health. This greatly affects the users of the building. There are several aspects in the discussion on healthy buildings.

#### a. Natural ventilation

Because this building is a commercial building (hotel & entertainment center / casino), the spaces in the building are made as intimate as possible so that the space feels more private. Therefore, the interior of the building uses air conditioning rather than natural ventilation. However, the skypark has an open space where you can enjoy the air directly.

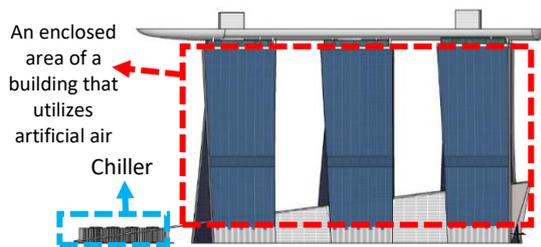


Figure 4. zoning of the use of air conditioning.  
(source: personal data)

#### b. Natural lighting

Lighting is the main source of this building, both as energy use and lighting aspects in the building. This building is designed to include as much sunlight as possible in order to provide maximum natural lighting for the spaces inside. The lobby area also has a wide opening where sunlight can enter and illuminate the large lobby area.



Figure 5. The lobby of the Marina Bay Sands which utilizes a wide opening as a place for sunlight to enter.  
(source: <http://kainarashakura.blogspot.com>)

#### c. Response to pollutants and noise

Although this building does not use greenery on the body of the building, the building is surrounded by greenery arranged horizontally which can have a good impact on the building (both as a light filter, reducing pollutants, and can reduce road noise in front of the building).



Figure 6. vegetation on the front of the building.  
(source: [www.googlemaps.com](http://www.googlemaps.com))

### Identification of building mass in eco-architectural concept

#### a. Building mass configuration

This building has 3 separate building masses but has the same shape and is connected by an elongated lobby and the 3 mass compositions support the skypark which is shaped like a ship at the highest part of the building. At the podium is the main lobby of the large hotel, then in the middle are the hotel rooms from the Marina Bay Sands. then in the skypark is a restaurant, a garden containing vegetation, and at the highest part is an infinity pool.

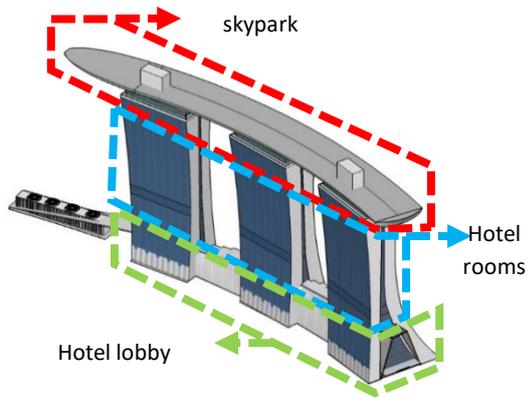


Figure 7a. Marina Bay Sands building mass configuration. (source: personal data)

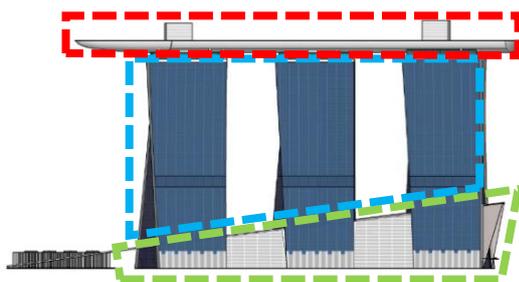


Figure 7b. konfigurasi massa bangunan marina bay sands. (sumber: data pribadi)

b. Building orientation

The building has an orientation that faces directly west to east. This causes sunlight to directly hit the spaces in the building in large portions. Of course, with the reception of large sunlight, the temperature in the room can rise quickly. Therefore, Marina Bay Sands has prepared automatic curtains that can close in order to keep the room temperature low.

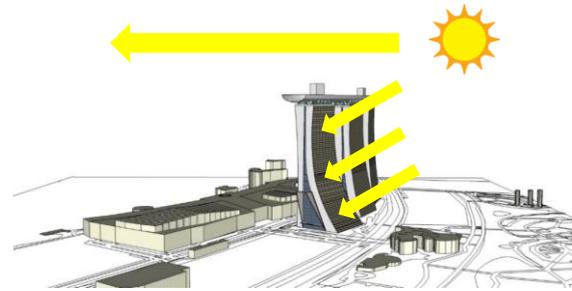
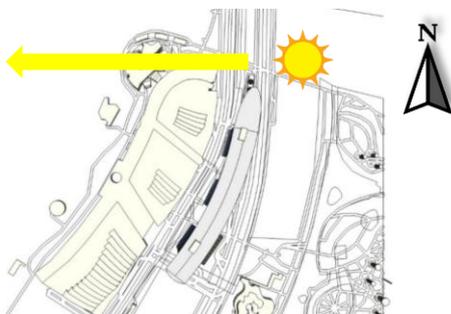


Figure 8. Sunrise towards Marina Bay Sands. (source: personal data)

CONCLUSION

In terms of building design, there are several advantages and disadvantages of using this concept in buildings, here are some advantages and disadvantages. Here are the drawbacks:

1. This building uses a hybrid energy system that allows saving on the use of electrical energy sourced from fossil fuels so as to reduce emissions and reduce building operational costs
2. The material used in this building is a common material in high-rise buildings with glass-dominant facades. This material itself actually has some bad impacts on the surrounding environment because these materials are obtained from outside the island of Singapore.
3. The top of this building is covered by a skypark which has a swimming pool and a garden above it so that it can keep the temperature inside the building low. In addition, around the building there is a lot of vegetation to filter the sunlight that enters the building and reduce the surrounding noise.
4. The orientation of the building is facing the direction of the rising and setting points of the sun. Therefore, Marina bay sands maximizes the potential that enters the room in order to reduce the use of lights. Because the sunlight received is too much, so there is an automatic cover that can cover the room with curtains to keep the room temperature low which has an impact on saving usage. air conditioner.

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