ARCHITECTURE ECOLOGY IN TECHNOLOGY CENTER DESIGN OF AEROPONIC AGRICULTURAL IN MALANG

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ABSTRACT

Technology Center Design of Aeroponic Agricultural is a container or means for researching and developing cultivation by means of aeroponic system to maximize result, quantity and quality of crop products that can be utilized by the general public, students, researchers and farmers to obtain learning and training. The approach to this design uses architecture ecology that serves to avoid harm to ecosystems, biodiversity, and humans. This approach responds to the design of utilities, energy supply, social, and human behavior so that the results of such an application will be able to prevent human caused natural disasters. In addition, this approach is applied to preserve the surrounding environment, produce the best agricultural products and improve environmentally conscious farming.

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INTRODUCTION

In the modern world as it is today, the development of science, technology and various aspects is very rapidly. Humans are competing to meet their needs by using it. But most do not care about the environmental impact. Natural disasters such as droughts, landslides, floods and fires are the result of uncontrollable human activities to meet their needs, although not all natural disasters are caused by humans.

In 1982-1992, the decrease in ground level in Jakarta ranged from 0.8 cm per year, much different in 2008, the decline is very drastic to 18-26 cm per year. The main cause is excessive groundwater extraction by buildings without conserving water even now the water becomes polluted and difficult to find clean water [1]. Estimated Jakarta sinks could happen. The use of water vacuum pipes in Jakarta now reaches 60 cm [2]. To overcome this problem, Jakarta Provincial Government through its regional regulation prohibits cooperatives and individuals from using ground water in the area that is connected to Jakarta Water Supply Company (PDAM) [3]. Although there is already a ban, people still ignore the regulation and keep using ground water.

Not only nature, humans also need to be considered in terms of health. According to WHO, it is estimated that 30 percent of all buildings or buildings in the world have problems related to indoor air quality. It affects human health in it, called Sick Building Syndrome, a disruption to the quality of health in humans in buildings caused by air quality or pollution, lighting and so forth [4].

Repairs need big capital rather than prevention, as in Jakarta, to improve the condition of the land surface continues to decrease the cost requirement is not a small capital. The presence of Architecture Ecology helps overcome it to harmonize nature, man and technique.

In practise, ecology provides information about environmental damage affecting living things and how to improve them [5] so that architecture needs to practice ecology in its design. There are three things to consider in designing ecological architecture ecosystems (biotic and abiotic), biodiversity, and human.

First, ecosystems, simply consists of biotics and abiotics, are interconnected, for example in carbon dioxide gas (abiotic), this gas is needed by plants (biotic) to photosynthesize to produce oxygen, but this gas is required as a measure if excess gas causing a greenhouse effect that causes global warming. Secondly, biodiversity, compared to deserts and forests, biodiversity in the forests is higher than deserts, if biodiversity is

reduced then the condition could be like in a desert that has little or no life, it is difficult to live and will affect climate change, loss of productivity and so forth. Third, humans, humans need to live quietly with clothing, food and board but this is the most basic needs and even other factors that are expressed by Zoer'aini in the book of ecological principles of ideology, politics, economy, social, culture, and defense.

There are considerations in designing ecological architecture that is key factors or factors causing environmental damage that affect the survival of ecosystems (biotic, abiotic), biodiversity, and humans. In this case, the focus on this design is agriculture, agriculture can also damage the natural balance such as converting forests into paddy fields, excessive use of chemical pepticides and so on. If modern agriculture uses artificial light that requires electricity, it could be more electricity than a building's electricity usage would be a burden for the State to add power supply, something to worry about is the country's electricity source derived from fossil fuels and coal will be more natural damage.

So it can be concluded by using the architectural ecological approach, this design is expected to be able to apply something alternative to the growth of agriculture without harming these three things so as to prevent natural disasters caused by humans to preserve the surrounding environment, produce the best agricultural products and increase conscious farming environment. The purpose of this research is to apply architecture ecology in Technology Center Design of Aeroponic Agricultural.

METHOD

Strategy in designing this concept using systematic data analysis method. Using this strategy will be able to complete the design stage from start to finish.

1. Idea formulation

These processes and stages are the search for ideas, affirmations of the Qur'anic and Hadith as the integration of Islam, the affirmation of design ideas, the development of ideas and designs that are poured into scientific papers.

2. Data collection

Data collection to help describe the design object. The data were obtained from various literature sources and field survey results Then reviewed in depth to adjust to the design. The following data sources will be obtained:

a. Primary date, this primary date has taken directly from project form project survey and documentation,
b. Secondary date, this date has taken from library study source from Qur'an and Hadist, book, study journals, and internet related agriculture, aeroponic cultivation, Ecology Architecture, aeroponic plants, garden, and Islamic Integration.

3. Designing analysis

This analysis step is for processing design with another more accuracy alternatives for design, this process doing the filter date and information for solving the problems until appear the solution as alternative design. The analyse date below:

a. User analysis,
b. Form analysis,
c. Land analysis.

4. Concept design

After doing the analyse date, then concept design, this step choose and sorting out from some design alternative appear from analysis step or merging from all with complete the standar and limits. The limits reffering from Qur'an and Hadist also Ecology Architecture theme to appearing the exactly design. This step is presented on sketch and picture. Some design concept which presented are basic concept, land concept, and view.

RESULT AND ANALYSIS

Architecture Ecology

Ecological attitude is able to balance the quality of life of ecosystems, biodiversity, and humans themselves then in building a design needs to have an ecological attitude. The design of ecological attitude needs to consider key factors or factors causing environmental damage that affect ecosystem survival (biotic, abiotic), biodiversity, and humans. The ecological theory of this architecture which consists of 5 things are as follows:

1. Accuracy of site development

The selection of design land is the most important thing in relation to ecology. Frick & Mulyani (2006) [6] cites the site repair of Christopher Alexander who explains that building is not in the best location but the worst location, using the worst location is how the design can be sustainable with the ecosystem and make it more precious, beautiful, comfortable, and healthy.

2. Energy efficiency and energy savings

How the design is minimally involved in the exploitation of energy-producing nature such as fossil power plants. The source of most carbon fossil energy emitter after coal is therefore the design needs to conserve energy and use it as efficiently as possible.

3. Maintenance of environmental sources (air, water, soil)

Water is the most basic requirement for living things but if this water is consumed excessively will cause drought, resulting in death for the living beings around it then this water needs to be maintained in terms of quality and quantity. Basic needs of water up to 25% of water supply [7].

4. Material

Considering the origin of the source of the material is very important whether the source of the material comes from natural ecosystems with high biodiversity or not and whether the source requires high transportation or not, due to the high need for transportation then it uses fuel that can increase carbon emissions. Ecological buildings conserve the material chain and use natural building materials [8].

5. Health and comfort

Lack of user comfort the higher the use of artificial technology to provide user comfort, such as the temperature of the building is too high will cause the high use of energy to AC (air conditioning) but such behavior is far from the ecological behavior therefore the need for building processing to the user comfort so that users feel the comfort without using technology that drains too much energy.

Location Data

Site location is located on Ngijo Road in Kepuharjo Subdistrict, Karangploso Subdistrict, Malang Regency. This location is located south of Ngijo Road which is a secondary arterial lane and adjacent to A. Yani Road which is the primary arterial lane.

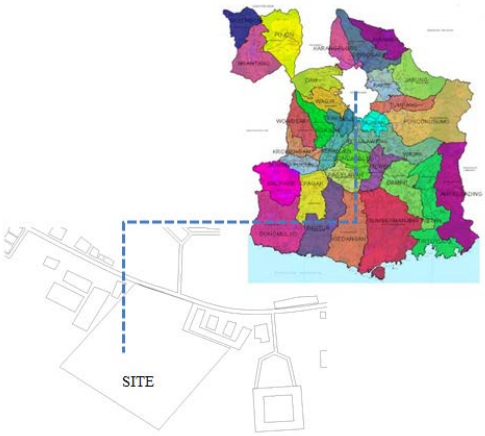


Figure 1. Map of Regency of Malang

The condition of the front site there are unused buildings and has been flattened with the ground, the condition of the tread on the back is a field. In some parts there are also irrigated rice fields. Because this design is also related to agriculture and rice field is still on its function only the difference of the system then it is not called destructive rice field ecosystem and still in the siting election on the design approach.

Figure 2. Site conditions

The design site has the andosol soil type with the size of the footprint 35217.8 m2, the detail of the site as follows:

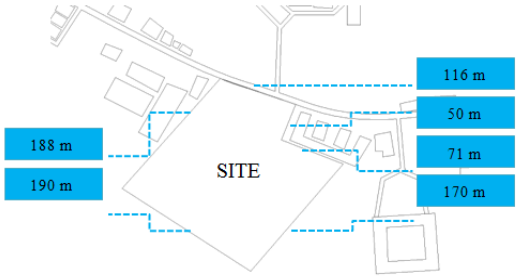


Figure 3. Site Size

Environmental conditions of the site there are various kinds of shops that are growing rapidly around this region besides the distance of 3 km to the east of the site is PT Bentoel Group, a cigarette factory operates. The boundaries around the site are shown in the following figure:

North : BALITAS and tourist market,
East : BPTP JATIM,
South : Rice field,
West : Tube repair shop and settlement.

Figure 4. Environmental conditions

In detail the coordinates of the main site location are at 112.621750 to 112.622197 east longitude, -7.911596 to -7.911945 south latitude with a land height of 523 m above sea level. Currently, the land is used in the form of former land of tavern and some as a land of rice field. Average annual rainfall of 1723 mm and wind speeds reach 24km/h at 10.00 to 14.00.

Design

Basic concept starts from Allah on Yunus (10), paragraph 101: Said: "Take note of what is in the heavens and the earth, and it is no use for the signs of Allah and the apostles to warn the unbelievers." In Tafsir Ibn Kathir states that God gives direction to His servants to think about His favors and in what Allah created in the heavens and the earth from the great verses for the people of reason. From there came the idea of the concept of *Simbiosis Komensalisme*.

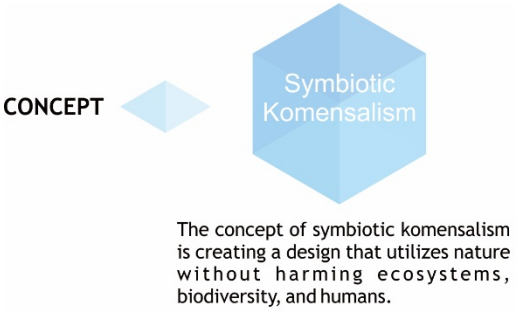


Figure 5. Basic concepts

Differnt from symbiotic mutualism that is mutually beneficial between two parties, the symbiotic komensalism benefits one party but does not harm the other, so the concept of symbiosis komensalisme is more focused on the benefits gained by the design with the maximum. The concept generates this form that is adapted to ecological principles related to the accuracy of site development, energy efficiency and space health. This formation is based on wind utilization.

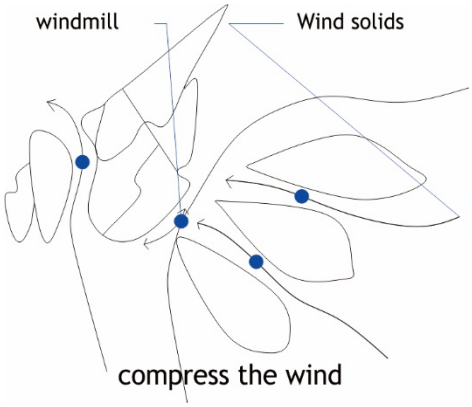


Figure 6. Form concepts

The concept of utility in the Technology Center Design of Aeroponic Agricultural is more on the wastewater treatment system because this design has a laboratory and plant production unit that can produce liquid waste that endanger the environment so that this design uses anaerobic wastewater treatment

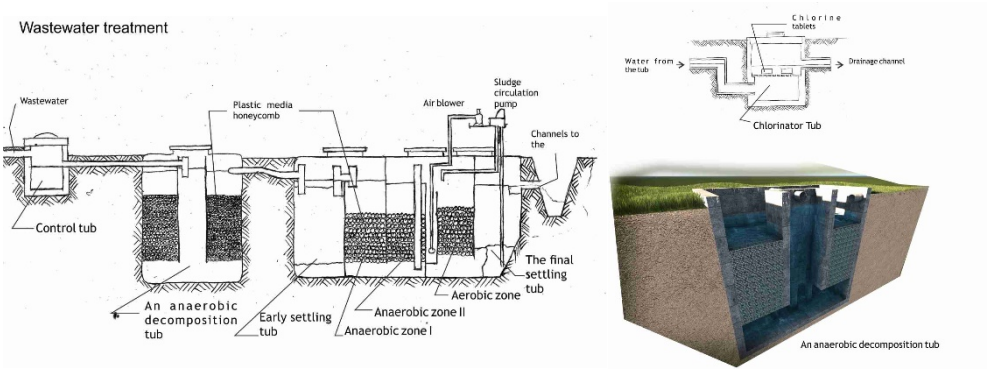


Figure 7. Utility concepts

At the Technology Center Design of Aeroponic Agricultural using the concept of Symbiotic Komensalism applied to the design of the region is the response to the wind climate with the arrangement of the center of the building to respond to the movement of wind in order to accelerate the wind speed that can be utilized for alternative energy using windmills.

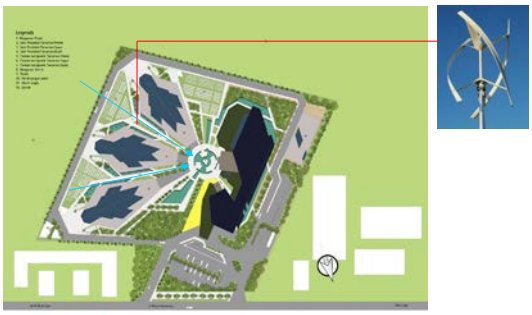


Figure 8. Area design

This form applies the principles of architecture ecology in which the design of this design centered to adjust the wind direction to be able to use the wind as a source of energy captured by the windmill. This centric designed building applies two floors to be able to expand green open spaces, in addition to centralized parking placement at the front of the site to maximize the pedestrian path. In figure (9) seen the parking lot of the visitor's vehicles to use to reduce the spread of disruption from vehicles including voice and air.

Figure 9. Design perspective area

Figure 10. Design looks area

As in ecological principles related to energy efficiency and health, this building applies bright colors and implements dollar crops (Zamioculcas Zamifolia) in order to absorb sunlight which consequently does not cause an increase temperature in the space contained therein, dollar crops (Zamioculcas Zamifolia) look green on the wall in the picture (11).

Figure 11. Design perspective center building

As in ecological principles related to energy efficiency and health, shown in figure 12, this building applies a bright color in order not to absorb heat which may cause increased heat in the room as well as in figure (12) Out functioning gable also serves as a reduction of pavement on the area so that green open space wider.

Figure 12. Design perspective unit of production

This service building serves as a service center for all activities in the design, central regulation of the flow of electrical energy that comes from alternative energy as well as from PLN and the management of water sources derived from rainwater and PDAM. This building there is only one zone that is the private zone consists of panel space and warehouse.

The building is located at the end of the overall design (figure 13) because this building is private only accessible to the manager and away from visitor access, thus avoiding the disruption caused by the activity present in this building to the activity of other buildings.

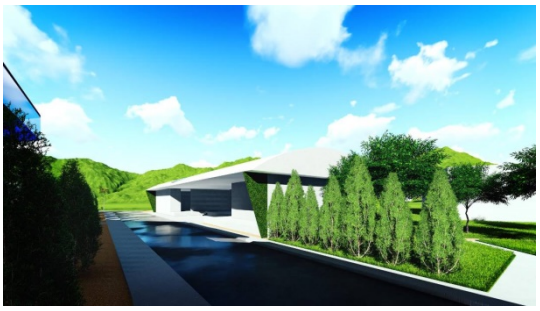


Figure 13. Design perspective service buildings

The Technology Center Design of Aeroponics Agricultural has three sources of electrical energy. The main source of this design applies the architectural ecological principle of the windmill of the wind movement that has been shaped as a result of the rearrangement of the building's centering period. The second source comes from PLN where this source is not recommended. The last source is the source of the backup comes from a gasoline or fuel oil generator (Fuel Oil). All of the region's electrical settings are in the service building. The location of this electrical plan can be seen in figure (14), visible electric current from windmill generator and PLN directly to panel room in service building.

Figure 14. Electrical plan

This Gallery Room is a supporter of the Technology Center Design of Aeroponics Agricultural, this room serves as a distributor of information and knowledge about aeroponic farming including agricultural history presented using VR (Virtual Reality) technology so as to view 360º (figure 15) and vehicle simulators (figure 16) As well as agricultural tools so as to not only see and hear but also feel how to use agricultural tools that exist all over the world, this simulator is also presented in the form of game (game). In addition, this room is also a social place.

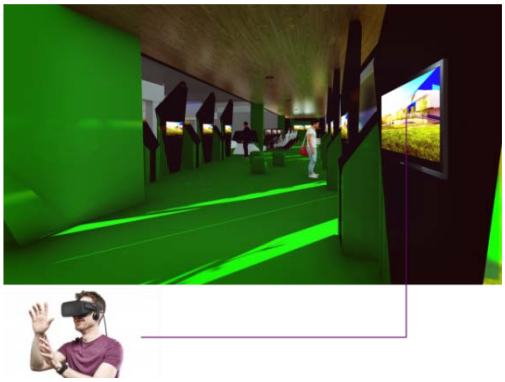


Figure 15. Galery room

Figure 16. Galery room

This indoor production unit space is the main function of the Technology Center Design of Aeroponics Agricultural, this room serves as a research and development tool related to the growth of plants with aeroponic system. In contrast to outdoor production units and greenhouses, this room develops plants using artificial sources in LED lights. Seen in the image (17) cultivation of plants using aeroponic system is in a closed room with LED light source.

Figure 17. Unit of production indoor

Space outdoor production unit is a major function of the Technology Center Design of Aeroponics Agricultural, this room serves as a research and development tool associated with the growth of plants with aeroponic system. In contrast to indoor and greenhouse production units, this room develops plants with open systems with natural lighting. Seen in the figure 18 crop cultivation using aeroponic system is outdoors without roof cover with natural light source.

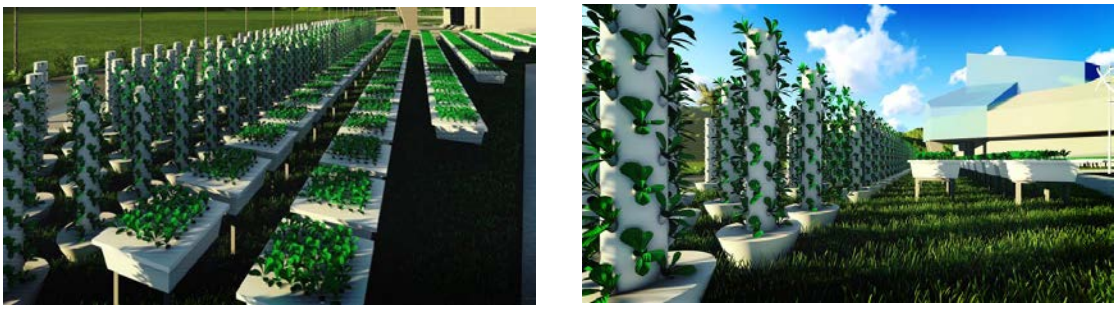


Figure 18. Unit of production outdoor

This greenhouse room is a central function of the Technology Center Design of Aeroponics Agricultural, this room serves as a research and development tool related to the growth of plants with aeroponic system. In contrast to outdoor production units and indoor production units, this room develops plants with closed systems by transparent roofs of polycarbonate material. Seen in the figure (19) cultivation of plants using aeroponic system is in a closed room (glass house) with natural light source.

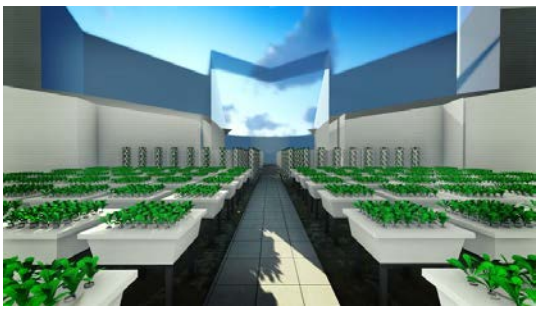
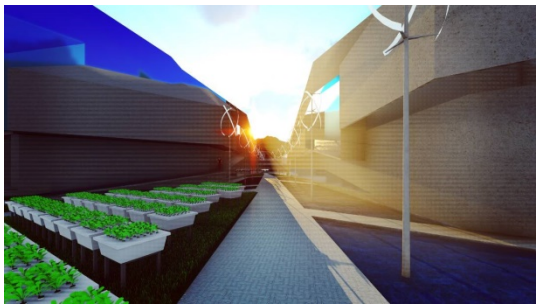


Figure 19. Glass house

This social space is a supporter of the Technology Center Design of Aeroponics Agricultural, this room can be used as a gathering place for visitors and managers. Seen in the picture (20) the center of this design area that can be used as a public space surrounded by water pool in order to cool impressed.

Figure 20. Social space

This windmill area as a supporter of the existence of electricity sources and as a major source of electricity at the Technology Center Design of Aeroponics Agricultural. In this area there is a tool of windmills within 3 meters of each windmill used to capture the wind that has been compacted by the arrangement of existing buildings beside it. Seen in the figure (21) the location of this windmill between the building of the plant production unit which as the pattern of the mass centroid follows the direction of the wind.



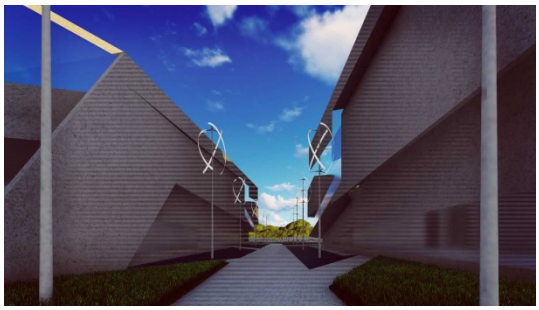


Figure 21. Windmill area

CONCLUSION

The application of ecological architecture is not only greening the design by planting trees, but also affect the shape of the design, installed utilities, materials used, spatial arrangement, and circulation patterns in detail. All that to meet from the principles of ecological architecture is to consider key factors or factors causing environmental damage that affect the survival of ecosystems (biotic, abiotic), biodiversity, and humans.

The concept applied in this design is a symbiotic komensalism which utilizes the natural surroundings without affecting ecosystems, biodiversity, and humans. the concept of symbiosis komensalisme is more focused on the benefits gained by the design with the maximum. The concept generates this form that is adapted to ecological principles related to the accuracy of site development, energy efficiency and health. Implementation of the concept is a design that can reduce waste yields, reduce electricity dependence, reduce water dependence, pour the effects of urban island, while also maximizing human needs itself without disturbing the surrounding ecosystem.

REFERENCES

[1] Aziz, Abdul. (Desember 2011). Jakarta Semakin Tenggelam. abdulaziz-fkp10.web.unair.ac.id. Diakses Maret 2016, dari abdulaziz-fkp10.web.unair.ac.id/artikel_detail-38894-Umum-Jakarta%20Semakin%20 Tenggelam.html
[2] Republika. (Februari 2016). Perjuangan Warga Mendapatkan Air Bersih. www.republika.co.id. Diakses Maret 2016, dari www.republika.co.id/ berita/koran/urbana/16/02/15/o2kzo621-perjuangan-warga-mendapatkan-air-bersih
[3] Republika. (Februari 2014). Jakarta Darurat Air Tanah. brpamdki.org. Diakses Maret 2016, dari brpamdki.org/news_detail.php?id=72
[4] BPN. (2011). Green Building A Sustainable Consept for Construction Development in Indonesia [PDF file]. Diambil dari penataanruang.pu.go.id

[5] Burnie, David. (April 2005). Bengkel Ilmu Ekologi (pp. 6-8). Jakarta: Erlangga.
[6] Frick, H & Mulyani, T.H. (2006). Arsitektur Ekologis. Yogyakarta: Kanisius
[7] Frick, H & Mulyani, T.H. (2006). Arsitektur Ekologis. Yogyakarta: Kanisius
[8] Frick, H & Mulyani, T.H. (2006). Arsitektur Ekologis. Yogyakarta: Kanisius