Sustainable Architectural Design of Heinz Frick Home: Coping with the Global Challenges in the Asian Cities

Lo Leonardo Agung Mulyono[1], Devi Calista Silvanus[2], and Gunawan Tanuwidjaja[3]

[1] *Students of Department of Architecture, Petra Christian University, Indonesia*
E-mail: leonardo_am@windowslive.com

[2] *Students of Department of Architecture, Petra Christian University, Indonesia*
E-mail: depi_calista@hotmail.com

[3] *Lecturer of Department of Architecture, Petra Christian University, Indonesia*
E-mail: gunte@peter.petra.ac.id

Abstract: Global challenges were faced by the world such as natural resource depletions, irregular weather pattern, and extinctions of biodiversity, loss of eco-habitats, pollutions and poverty (Miller, 2003). The Green Design Strategy was proposed by developed countries such as United States Green Building Council, International Union of Architect (UIA), etc. On the other hand, the strategy could not be fully implemented in developing and under-developed countries because of financial issues. Dr. Heinz Frick'shouse in Semarang was an example how the local Javanese wisdom as and green approach could be integrated but still affordable. The 140-square-meter house was built in 1999, for 150 millions rupiahs only. Some low cost and innovative designs were proposed in the cross ventilation, recycled materials, and rainwater collection. The house also received nomination Aga Khan Award showing a successful case of cultural integration in the sustainable architectural design in the Asian city.

Keyword: *Sustainable Architectural Design, Cultural Approach, Appropriate Green Technology, Affordable Home*

1. INTRODUCTION

Global challenges were faced by the world such as natural resource depletions, irregular weather pattern, and extinctions of biodiversity, loss of eco-habitats, pollutions and poverty (Miller, 2003). It was caused by increase of world's population from 2.521 billion to 6.782 billion from 1950 to 2009. And the world's population was predicted to reach 9 billion by 2040. And it caused greater pressure to Earth environment especially in urban areas. [1]

The urbanisation in developing countries occurred rapidly in the 20th Century (Schultz 2006). Schultz stated that urban population had increased from 30% from total world population in 1950 to 50% in 2007. And even it was predicted to reach 60% in 2030. This further created the "Mega Cities" (cities with population of more than 5 million persons) in developing countries. 60 Mega Cities would emerge in the developing countries, especially in Asia, in 2015, consisting approximately of 600 million populations.

[1] http://www.census.gov/ipc/www/popclockworld.html, estimated by United States Census Bureau on 5th September 2009; http://au.encarta.msn.com/encyclopedia_1461501471/Population_Explosion.html; http://en.wikipedia.org/wiki/File:Population-milestones.jpg

The Megacities development would affect the environmental condition of the areas. Furthermore, population increase could cause insufficient housing, urban sprawling and urban degradation. And the Megacities also would become vulnerable due to Climate Change, i.e., cyclones, high winds, flooding, coastal erosion and deposition, and sea-level rise.[2]

The Green Design Strategy was proposed by developed countries such as United States Green Building Council (USGBC), International Union of Architect (UIA), etc. International Union of Architect (UIA) recommended to reduce the climate change impact with the "Sustainable by Design Strategy" in Copenhagen Declaration on 7th December 2009. Meanwhile USGBC recommended LEED (Leadership in Energy and Environmental Design) a leading-edge system to certify the green building in the world, including the LEED for Homes. On the other hand, the strategy could not be implemented in developing and under-developed countries because of financial issues, for example: In Indonesia, poverty affected the 49.0% of the population live on less than US$2 per day and unemployment rate reached 9.75% (World Bank, 2006).

The Home of Dr. Heinz Frick, located in Jalan Srinindito, Simongan, Semarang, has environmentally friendly design features and was still affordable. Design of the Green Home has attracted the public interest because of the green and unique design. For the record, when the House, 140 square meters building area and 350 square meters land parcel, was built in 1999, the house only cost Rp. 150 millions (Frick, 2000). It showed that green and affordable home design could answer the housing need for the lower-and-middle-income Indonesian. It also showed that local wisdom and the appropriate technology could produce an affordable green home designs. The house received nomination Aga Khan Award [3], therefore it shows a successful case of cultural integration in the sustainable architectural design in the Asian city.

2. LITERATURE STUDY

International Union of Architect (UIA) recommendation on the "Sustainable by Design Strategy" could be described in 9 recommendations. Meanwhile the most important recommendation were: [4]

- Sustainable by Design should begin with the earliest stages of a project and needed commitments between all the stakeholders: clients, designers, engineers, authorities, contractors, owners, users and the community.
- Sustainable by Design needed to incorporate all aspects of construction and future use based on full Life Cycle Analysis and Management
- Sustainable by Design could optimise efficiency through design. Renewable energies, high performance and environmentally benign technologies could be integrated to the greatest practical extent in the project conception.
- Sustainable by Design would seek healthy materials for healthy buildings, ecologically and socially respectful land-use, and an aesthetic sensitivity that inspires, affirms and ennobles.

---

[2] http://www.kas.de/upload/dokumente/megacities/VulnerabilityofGloballCities.pdf
[3] http://archnet.org/library/images/sites.jsp?select=collection&key=283&order_by=country&collection_id=283
[4] http://www.uia-architectes.org/texte/england/Menu-7/3-bibliotheque.html
http://www.uia-architectes.org/image/PDF/COP15/COP15_Declaration_EN.pdf

- Sustainable by Design aimed to significantly reduce carbon imprints, hazardous materials and technologies and all other adverse human effects of the built environment on the natural environment.
- Sustainable by Design endeavoured improving the quality of life, promoting equity both locally and globally, advancing economic well-being and providing opportunities for community engagement and empowerment.
- Sustainable by Design endorsed UNESCO's statement that cultural diversity, as a source of exchange, innovation and creativity, was very important for humankind.

It could be concluded that the UIA has recommended a strategy to reduce the climate change and environmental degradation. To be able to implement the strategy, the more detail recommendation was needed such as LEED for Homes. LEED for Homes is a design strategy that improve the efficiency of resources uses with integration of environmental friendly principles in the home design-construction process. There were 8 criteria that were discussed in Guideline which were: Innovation and Design Process (ID); Location and Linkages (LL); Sustainable Sites (SS); Water Efficiency (WE); Energy and Atmosphere (EA); Materials and Resources (MR); Indoor Environmental Quality (EQ); and Awareness & Education (AE). [5]

3. METHODOLOGY

This research was conducted with secondary data collection on Dr. Heinz Frick's House. Later on, two visits were conducted to interview the current owner and to document visually. Besides that, Mrs. Regula Frick contributed additional data on the House. Lastly, final analysis and report writing were conducted.

4. DISCUSSION

The house is located on the Simongan Hill, nearby an industrial area, on the south of Semarang. The soil of the hill was less fertile and was ideal for residential use by Dr. Heinz Frick, because it did not diminish the productive agricultural land. The hill had been cut up partially for Semarang coastal reclamation and this actually threatened the sustainability of communities living here. So the house was built to advocate for this community to protect their environment. Further, the description of the sustainability of Dr. Heinz Frick's House would use The Sustainable Architectural Design Strategies for Indonesia framework by Tanuwidjaja and Lo (2011). There are three main aspects in the framework, which are the Economic Aspects, Social Aspects and Environmental Aspects.

Figure 1. Dr Heinz Frick's House

Figure 2. Dr Heinz Frick's House

Figure 3. Simongan Hill where Dr.

[5] http://www.usgbc.org/
http://greenhomeguide.com/askapro/topic/12

environment environment House. Heinz Frick was located

Source: http://archnet.org/library/images/one-image-large.jsp?location_id=11714&image_id=99937

Table 1: The Sustainable Architectural Design Strategies for Indonesia and the Implementation in Dr Heinz Frick's House

General Aspects	Primary Aspects	Sub-Aspects	Implementation in Dr. Heinz Frick's House
The Economical Aspects	Improving Quality of Live (especially Local Poor)		Fully
	Functionality		Fully
	Cost Effectiveness & Efficiency		Fully
	Integrated Design – Construction – Management Process		Fully
	Security		Fully
	Safety	• Structural Safety	Fully
		• Earthquakes & Tsunamis Safety	Fully
		• Floods and Landslides Safety	Fully
		• Extreme Weathers Safety	Fully
		• Fires Safety	Fully
	Future Adaptability		Fully
The Social Aspects	People Awareness for Sustainable Design		Partially
	Legal Protection		Fully
	Participatory Design Process involving all stakeholders		Partially
	Aesthetics		Fully
	Cultural Diversity Preservation		Fully
	Social Inclusiveness	• Facilitating Social Interaction	Fully
		• Universal Accessibility	None
The Environmental Aspects	Appreciation of Interrelation-ships with the Environment	• Location Selection	Fully
		• Micro-climate	Fully
		• Site Planning and Design	Fully
		• Environmental Impact Assessment	Partially
	Full Life Cycle Analysis and Management	• Thermal Comfort	Fully
		• Building Materials	Fully
		• Water Efficiency	Fully
		• Energy Efficiency	Fully
		• Waste Management	Fully

Because of limited pages in the paper, only the most important aspects were discussed here.

4.1. ECONOMICAL ASPECTS

The Economic Aspect would be described as followed: Firstly, improving quality of live especially local poor, was achieved in the design by using local labour and local materials such as concrete brick, natural stone, recycled wood, roof tile and steel (Yusita et.all. 2011).

Besides that, the recycled waste materials were used such as: recycled floor tile, recycled paper, recycled wood and reinforcing bar, and it inline with the sub-aspects of sustainable building materials. [6]

Second, the aspect of functionality was fulfilled by optimising function of the building. A Master Bedroom, 2 Guest Bedrooms, 2 Bathrooms, and West Terrace is part of the building including private zone (private zone). [7] Then, the Kitchen, Dining Terrace, Living Room, Library and Work Space, also the South Terrace is a semi-private zone. Frick used the slope of the land with a two-story building design. This shows the optimality of functionality as well as solutions to the problems of land. Function of the home was found optimal because adequate size of each room, beautiful existing scenery and adequate lighting (Yusita et.all. 2011). The House plan would be illustrated in Figure 6.

Third, aspect of cost effectiveness and efficiency was achieved with cost-effective building structure and building material, also efficient finishing. The house is equipped with an effective structure with a concrete strip foundation (stepped because of the slope). The ground floor of this building was a concrete coated with asphalt. [8] By combining concrete rigid frame structure, concrete deck (supported by concrete-block-vault) and natural stone walls supporting the external parts, the Home met the Safety Aspects, especially the Structural Safety, Earthquakes & Tsunamis Safety). Meanwhile, the tsunami was not a threat to this area because it is located far from the sea. Building element consists of the Strip Foundation, Ground Beam, Columns, Beams, Walls, Floors, and Roofs. Foundation selected by the Frick is the mix system of concrete and rocks (cyclopean concrete). Onsite soil was hardened soil (and need to be dug with a crowbar). Because of that, Strip Foundations of 50 cm width and 40 cm height were found sufficient to bear the load. In addition Ground Beams (reinforced concrete) size 20 cm by 30 cm were placed to tie the column to each other (Frick, 2000).

Construction of the wall utilised the concrete block (with 10 cm thickness). Meanwhile, in the facade exposed to the sun, 20-cm-thick natural stone layer was applied. The solution would improve the Thermal Comfort. It could slower down the solar radiation to reach the interior for 8.5 hours. And it meant that the afternoon solar radiation on the west side of the home would reach the interior by night. And this fulfilled the aspect of Thermal Comfort Sub-aspect (Frick, 2000).

Three-meter-span-concrete-block-vaulted floor plate construction was applied on top of the Workshop and Rain Water Container. It actually saved the construction costs because of effectiveness of the vault reduce the steel reinforcement. Concrete reinforcements were still applied on the beam receiving considerable horizontal loads. Dr. Frick's research found that concrete-block-vaulted floor plate construction could bear the load of 4kN/m2 for 24 hours without cracks or significant deflection. So, similar construction was applied on the Bedrooms as well to reduce the thermal radiation (Frick, 2000).

Aspect of Security of the home was fulfilled with positioning kitchen overseeing the dining terrace, as the main entrance. Then, the concrete-iron railings on the windows and fence around the house were set up for maintaining the security of the building.

---

[6] http://archnet.org/library/sites/one-site.jsp?site_id=9723
[7] http://archnet.org/library/sites/one-site.jsp?site_id=9723
[8] http://archnet.org/library/sites/one-site.jsp?site_id=9723

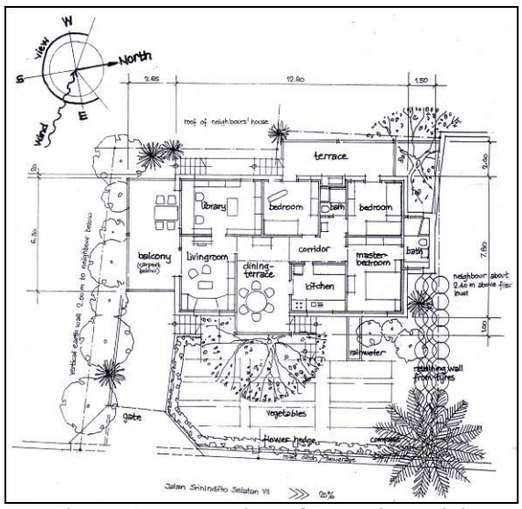

Figure 4. House plan of Dr Heinz Frick
Sources: Personal documentation Dr. Heinz Frick

Figure 5. Main Bedroom

Figure 6. Guest Bathroom

Figure 7. Kitchen

Figure 8. Dining and Living Terrace

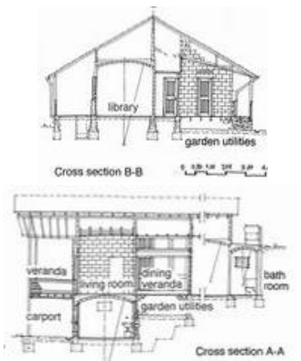

Figure 9. Dr. Heinz Frick's House Section

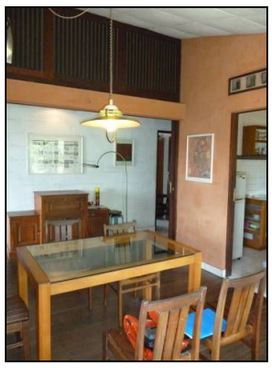

Figure 10. Concrete Rigid Frame Structure

Figure 11. Vault Structure from concrete block

Figure 12.Bearing Wall from natural stone

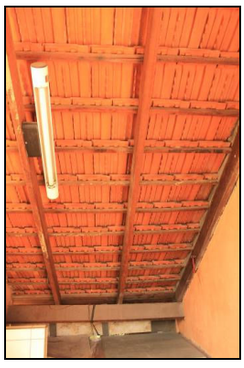

Figure 13. Construction of The Roof consisted of rafters, batten and tile

In addition to that, the Floods and landslides safety was considered and the house was not exposed to flooding. Meanwhile the chances of landslides were mitigated by concrete strip foundation. The Extreme Weathers Safety was also considered. The biggest threat of lightning strikes was solved by making the grounding using copper wires under the concrete strip foundation. Each electrical socket outlet was connected to three wires, one of which is the grounding (Yusita et.all. 2011). Meanwhile, the Fires Safety was guaranteed with building the Kitchen on the separate zoning of the Bedroom and Library.

4.2. SOCIAL ASPECTS

The Social Aspect would be described as followed: Promotion of People Awareness for Sustainable Design was conducted by Dr. Frick with the construction of the House. Therefore, the neighbouring community knew more on this Ecological Home design. Unfortunately, due to economical limitation, they found it difficult to implement the concept to their homes. Another Dr. Frick's effort in this was to build the Small Community Centres (*Balai Rukun Tetangga)* with similar concept. Besides that, the Promotion for Sustainable Design was successful with visits of many architects, researchers and undergraduate students to learn about this Ecological Home.

Aesthetics Aspects was really thought in the Dr/ Frick's House design. The proportion, which was simple and unique, gave unique image to the House. This was clearly described in the Elevation of the House presented in following Figure.

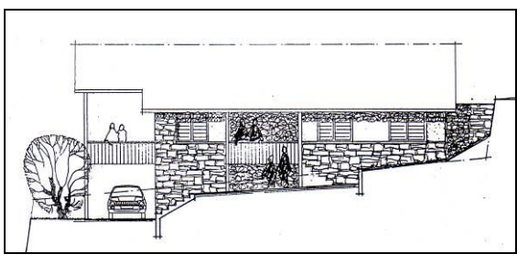

Figure 14. Elevation of Dr. Frick's Ecological House

Figure 15. Perspective of Dr. Frick's Ecological House

Cultural Diversity Preservation Aspect and Social Inclusiveness Aspect were very appreciated by Dr. Frick. The willingness of Dr. Frick and Mrs. Regula to adopt the Javanese Culture was translated into their lives and the House design. Their favourite meal is the Javanese food and other Javanese culture. In the design, the Pendopo Space in Joglo House (Traditional Javanese House) concept for social interaction was adopted. It was translated into the Dining Terrace that was used for interaction use such as religious celebration, women social meeting and Women Empowerment Association (PKK) meeting as described by Javanese culture.

4.3. ENVIRONMENTAL ASPECTS

The Environmental Aspect would be described as followed: Appreciation of Interrelationships with the Environment Aspect was really taken into consideration by Dr. Frick. Because he believed the Eco-Architecture principle that the House system is interconnected to the wider Ecological System (Frick, H. et.all., 1998).

Location Selection Sub-Aspect Environment was applied and really affected the quality of the Home. The House site was selected on the mountain slopes, with less fertile soil, so it did not reduce the productive land for agriculture. The site was land adjacent plot was selected from two acres of each 150 square meters. On location, a middle-and- low income Community lived there. And there were some threats toward their livelihood such as Government plan to cut the hill for the land reclamation, also waste-burning pollution in adjacent location (Frick, 2000).

Micro-climate Sub-Aspect was taken into consideration in the House design. Semarang was located 06º59'S 110º23'B, with elevation 3 m from sea level, therefore its climate was humid tropic. The City possessed Daily Temperature between 24-32ºC, Monthly Rainfall between 60-430mm/month, Day Time Relative Humidity 82-90%, Night Time Relative Humidity 59-78%, Average Wind Speed 6-11mph.[9] The data supported the concept of natural cross ventilation in the Home. To maximise it, several opening were provided such as: glass louvers window, ventilation opening on top of the window, and jalousie door. This actually maximised the air circulation and reduced the dampness in the room. Beside of that, to reduce the insect vector impact mosquito screens were installed on the windows, openings and doors. The natural day-lighting concept was adopted in the House with of openings design on the North, South and East side. Therefore, the skylight can reach all rooms and it can save electricity use. It was estimated that the saving reach 50% from neighbouring houses (Frick, 2000, Oetomo,W.R., 2008).

Site Planning and Design Sub-Aspect was implemented innovatively in the House design. The sloping land was utilised optimally with split level building design which was already described in the Functionality Aspect description. Besides that, there were Vegetables Garden ($80m^2$), the composting container, the rainwater collection tank, the septic tank, the car parking and some plants. It showed that Dr. Frick had thought through on the optimal use of the site (Frick, 2000, Oetomo,W.R., 2008).

Full Life Cycle Analysis and Management Aspect were implemented partially. Because of absence of life cycle analysis data on the building materials used in Indonesia. But, the

[9] www.weatherbase.com

approach of considering the life cycle of the House on the long period was thought by Dr. Frick.

Thermal Comfort Sub-Aspect was implemented by Dr. Frick in the House with zoning, material use, shading and canopy design. The Western part of the House, which faced the afternoon Sun Radiation, was equipped with 20-cm-thick-natural-stone wall, the sun shading on the windows and canopy. These three elements reduced the impact of radiation to the interior of this House. The natural stone wall was explained in the Economical Aspect. The steps to mitigate the humidity were needed because of humid tropic climate and hygroscopic nature of building materials can cause spreading of dampness into the building interior. One step to reduce the groundwater to dissipate in this House was to apply the waterproofing between the ground beam and foundation [10] or plaster, paint, [11] etc. The high humidity also could cause the health of the residents, such as: skin allergy, bronchitis and asthma. Therefore, the plastic layer was added on top of backfill and below the House floor (Frick, 2000, Oetomo,W.R., 2008).

Building Materials Sub-Aspect was implemented maximum in the House. The House's building materials were mostly recycled material such as used wooden formwork, recycled floor tiles, recycled papers, recycled woods, reinforcing bars, recycled electrical pole, recycled distribution panel. Besides that, the environmental friendly materials were used such as: paints and cleaners (Frick, 2000, Oetomo,W.R., 2008).

The wooden formwork used for the concrete pouring of the House was from Kalimantan. Unfortunately, after construction 70% of the wood were stolen, while the rest were given to the local people. Meanwhile, the Bangkirai rafter (5x7cm) from similar source were utilised for ceiling framework and Terrace railing. The broken floor tile from UNIKA were reused creatively for the floor and wall finishing in the Guest Bedroom. The ceilings of the House were designed with various recycled materials. Firstly, the acoustical panels from Vermiculit [12], which dismantled by PIKA (Advance Woodcraft Polytechnic) from other buildings, were used in the Kitchen, Dining Terrace and Living Room. Secondly, the wooden plank from the container which used for the Passage area to the Bedroom. Thirdly, the recycled woods from PIKA were used also for exhaust in the Kitchen's ceilings (Frick, 2000, Oetomo,W.R., 2008).

Environmentally-friendly paint was also applied in the House. Collaboration between UNIKA and AKIN since 1995 produced adhesive paint from tapioca flour, 5% of pine oil (for disinfecting insects and fungi), lithopone (white pigment), kaolin and talcum (filler). And the paints could be applied twice so the wall could be covered and not easy to be scratch. Additionally, crawler plants were planted on the West and South side of the House. The effect of the plant was cooling the House atmosphere (Frick, 2000, Oetomo,W.R., 2008).

Water Efficiency Sub-Aspect was implemented in the House based on Dr. Frick's experience for 6 years living in Kalimantan. The water supply concept was offered in the House, which was the rainwater utilisation for non-potable use, such as shower, closet flushing, washing,

[10] On the concrete building, waterproofing (tar, sealant or zinc sheet) could be applied on top of ground beam that was dried for minimum of 14 days. On the wood building, waterproofing could be installed on top of mortar layer and the split stone foundation, underneath the wooden ground beam..

[11] The wall material, plaster and paint should have a hygroscopic nature (waterproofed) so the dampness would not dissipate inside of the wall and to the roof construction. The synthetic paint was quite waterproof, allowing 2-9 g/m^2h water to absorb. Meanwhile, the adhesive paints or lime based paints allowed 15-17 g/m^2h water ot absorb.

[12] Mica that expand in the high temperature, mixed with cement and chemical agent

moping and watering the plants. Meanwhile, potable water was still taken from the Water Utilities Company (PDAM), the uses are for drinking, cooking and other basic need when rains unavailable. Rainwater from the roof was collected with gutter and later transferred by the downspout to two water tank on the ground level. Later, a pump was used to pump the rainwater to the third rainwater tank underneath the roof on the North side of the House. From this tank, the rainwater was distributed with gravitation principle to the bathroom, washing areas, and other taps (Frick, 2000).

The first rainwater tank (volume of $12m^3$) was allocated for household use. The tank was constructed from 20-cm-reinforced concrete floor and wall. This was carried out because low quality of concrete mix. Besides that, special chemical and pool paints were applied to make the tank waterproof. And the tank required more than 14 million Rupiahs. Second rainwater tank was located in the East side of the House (in front of Dining Terrace). The tank cover was made from mosquito net for screening leaves and contaminants from the roof, and to prohibit the mosquito to breed in it. Besides that, the rainwater in the tank was used for breeding fish and watering the plants in Vegetables Garden (Frick, 2000).

Additionally, the water from Utilities Company was also considered in the House. The tap water was collected in the water tank, located underneath the roof on the North side of the House, before distributed into the Kitchen. The tank capacity was $1m^3$. Besides that, the water saving strategy was conducted, such as using shower in the Bathroom, water saving in the washing, etc. Because of the rainwater utilisation and water saving strategy, around 80% of water utilities cost was saved (Frick, 2000).

Energy Efficiency Sub-Aspect was conducted with saving strategy for electrical supply from the Grid when the room was unoccupied. Therefore, each resident must turn off lamps and other electrical devices when they were unused. Besides that, a solar panel was provided to support the computer use. Later on, the solar panel was used for TV when the electrical supply was insufficient (Frick, 2000).

Waste Management Sub-Aspect was conducted maximum in the House. It was visible in the waste sorting, composting and household sewage handling. Generally, the waste was classified to three types, which were: leaves waste; paper waste; plastic waste, kitchen waste and hazardous waste (B3). The leaves were composted, the paper waste was incinerated, and the plastic, kitchen waste and hazardous waste were disposed to the Garbage Container (Frick, 2000).

Besides that, the sewage was processed using the Vietnamese Septic Tank. The Septic Tank comprised of two compartments with equal size. For 6 months, the first compartment was filled with faeces and urine. After 6 months, the sewage would be fermented and would not give bad odour anymore. The processed sewage could be used for fertiliser. After that, the second compartment would be used. The 6-months process was conducted to exterminate the coli bacteria, etc. that were present in the sewage. Lastly, the overflow water from septic tank would be channelled to the drain field made from the sands (Frick, 2000).

5. CONCLUSION

House design of Dr.. Heinz Frick, Semarang, has environmentally friendly and affordable design features. This was started with using local labour and local materials such as concrete

brick, natural stone, etc.; using recycled materials, such as used wooden formwork, recycled floor tiles, etc; and using environmental friendly materials, such as: paints and cleaners.

Secondly, the success of the House was supported with functional design which pays attention to adequate room size, beautiful existing scenery and adequate lighting. Thirdly, Dr Frick also built the House to promote people awareness for Sustainable Design, although it was not fully succeed due to need for social change in Indonesia. Fourthly, cultural diversity preservation aspect was appreciated by Dr. Frick, especially the Javanese culture. It was translated in the Dr. Frick's family life and the House design. For example, the Pendopo Space in Joglo House (Traditional Javanese House) concept was translated into the Dining Terrace that was used for the mentioned social interactions.

Fifthly, the implemented environmental friendly design strategy was to maximise cross ventilation and reduce the humidity by opening design such as: glass louvers window, ventilation opening, and jalousie door which were equipped with mosquito net. Lastly, water saving was implemented in the House design. It was conducted with the rainwater utilisation for non-potable use, such as shower, closet flushing, etc Meanwhile, water from the Water Utilities Company (PDAM) was used for drinking and cooking. It was a rationale solution. In conclusion, the Dr. Heinz Frick's was a perfect solution for Indonesia because of its appropriate and affordable design.

ACKNOWLEDGEMENT

We would like to express gratitude to:

- The late Assoc. Prof. Dr.-Ing. Ir. Heinz Frick, dipl.arch. FH/SIA
- Mrs. Regula Frick
- Mrs. Tuminem and family
- Mr. Agus Dwi Hariyanto, S.T., M.Sc. Head of Architecture Department, Petra Christian University
- Mrs. Ir. Joyce M. Laurens, M.Arch., Lecturer of Architecture Department, Petra Christian University
- Mrs. Yusita Kusumarini, S.Sn., M.Ds. Lecturer of Interior Design Department, Petra Christian University
- Mrs. Anik Juniwati, S.T., M.T. Lecturer of Architecture Department, Petra Christian University
- Mrs. Luciana Kristanto, S.T., M.T. Lecturer of Architecture Department, Petra Christian University
- Akhmad Kendra, S.T., Murtadho

REFERENCES

Frick, H., (2000), Report of Ecological Home Development in Semarang 1999, unpublished

Frick, H., Suskiyatno FX.B.. (1998), **Basics of Eco-Architecture *(Dasar-dasar Eko-Arsitektur),*** Yogyakarta: Kanisius.

http://archnet.org/library/images/one-image-large.jsp?location_id=11714&image_id=99937

http://archnet.org/library/images/sites.jsp?select=collection&key=283&order_by=country&collection_id=283

http://archnet.org/library/sites/one-site.jsp?site_id=9723

http://au.encarta.msn.com/encyclopedia_1461501471/Population_Explosion.html;

http://en.wikipedia.org/wiki/File:Population-milestones.jpg
http://greenhomeguide.com/askapro/topic/12
http://www.census.gov/ipc/www/popclockworld.html, estimated by United States Census Bureau on 5th September 2009;
http://www.kas.de/upload/dokumente/megacities/VulnerabilityofGloballCities.pdf
http://www.thejakartapost.com/news/2008/06/27/how-build-a-healthy-inexpensive-home.html
http://www.uia-architectes.org/image/PDF/COP15/COP15_Declaration_EN.pdf
http://www.uia-architectes.org/texte/england/Menu-7/3-bibliotheque.html
http://www.usgbc.org/
http://www.yearofplanetearth.org/content/downloads/Megacities.pdf
Miller, G.T. (2003), **Environmental Science, Working With Earth,** 10th edition, Brooks/Cole Thomson Learning USA, p1
Oetomo, W.R., (2008),House Series: **The Ecological and Comfortable Homes *(Serial Rumah: Rumah Nyaman, Ramah Lingkungan),*** Jakarta: PT Prima Infosarana Media.
Schultz, B., (2006), Opportunities and Threats for Lowland Development, Concepts for Water Management, Flood Protection and Multifunctional Land-Use. In Proceedings of the 9th Inter-Regional Conference on Environment-Water, 17 - 19 May, 2006.
Tanuwidjaja G., Lo L., (2011), Sustainable Architectural Design in Indonesia: Responding the Current Environmental Challenges, The 12th International Conference on Sustainable Environment and Architecture (SENVAR), Malang- Indonesia, November 10th -11th 2011
World Bank, (2006), "Making the New Indonesia Work for the Poor - Overview" (PDF). Press release., accessed in http://siteresources.worldbank.org/INTINDONESIA/Resources/Publication/280016-1152870963030/2753486-1165385030085/Overview_standalone_en.pdf.
www.weatherbase.com
Yusita, K., Ekasiwi, S. N. N., Faqih, M., (2011), A Contextual Theory and Application of Eco-Interior In Indonesia, **Australian Journal of Basic and Applied Sciences**, 5(11): 383-388, 2011, ISSN 1991-8178. p 384.