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Introduction of Plastered Bamboo Creative Eco-Design to Support Creative Infrastructure Improvement in Kediri

Tanuwidjaja, Gunawan[1], Lo Leonardo Agung Mulyono[2], Devi Calista Silvanus[3], Widyowijatnoko, Andry[4], Mustakim[5]

1.Petra Christian University, Indonesia, Email: gunte@peter.petra.ac.id,
2&3.Students of Department of Architecture, Petra Christian University, Indonesia
4.Institute Technology Bandung, Indonesia
5.Planning Agency of Thousand Islands Regency, Indonesia

***Abstract*—The UIA's Sustainable by Design Strategy (SBD) in Copenhagen Declaration highlighted the importance of reducing the impact of climate change in the Architectural Design. SbD recommended the healthy materials for healthy buildings design which also could improve the quality of life in the local scale. SbD also endorsed UNESCO's recommendation to preserve the cultural diversity. Ecological design is the answer to the phenomenon. It could be defined as the use ecological considerations in the design to seamlessly integrate the human built environment, human activities and the natural environment.**

This recommendation was fulfilled with plastered - bamboo technology and creative design. The abundant bamboo resources and bamboo craftsmen in Kediri area, Jatiwekas Sub-Village were the rationale for selecting the plastered - bamboo creative eco-design. The bamboo also fulfilled the healthy or sustainable materials criteria, such as low energy consumptions, low impact to environment, low construction cost.

The need of the Jatiwekas Sub-Village Community for integrated communal bathing-washing – toilet – water tank facility for housing infrastructure was found during the observation and community focus group discussion. The program involved socialisation and training of the plastered – bamboo design in the village. After accepting the technology, the people mapped out the need in the village (Participatory Rural Appraisal) and conducted a participatory design, facilitated by the Petra University Team. And it produced culturally-accepted and creative facility design. Finally, it would provide the community with alternative creative design options.

***Index Terms*—Sustainable material, plastered – bamboo design, integrated communal bathing-washing-toilet-water tank facility, participatory design.**

I. INTRODUCTION

Understanding the impact of building and construction industry's contribution to global warming, Union Institute of Architects (UIA) proposed Sustainable Design Strategy (Sustainable by Design / SbD). There were several recommendations such as: SbD should be implemented since the early stages of the project, SbD must optimize efficiency through design and find a healthy building materials. Lastly, SbD would continue to improve the quality of life especially in local scale and community empowerment. [1]

In response to the requirement of sustainable materials, bamboo was found as one sustainable material because it was derived from a renewable source, produced with small amount of energy, and minimum environmental impact, can disintegrated by nature, also can be constructed with local craftsmen and residents (Mendler, S., et al., 2000) [2].

Initiated by the Community Outreach Programme organized by Petra University in Jatiwekas Sub-Village, Kedawung Village, District Mojo, Kediri, an integrated program was proposed for a creative solution for the village's problem.

Great potential of bamboo was found in the area because of abundant bamboo materials and craftsmen. Unfortunately, bamboo technology was originally unaccepted by the local community because of the negative perceptions of the bamboo materials. Because of that, a creative socialisation, training and design were needed in the area. The purpose of the program was to find a creative socialisation and design process to increase the acceptance of the technology by the community.

II. METHODS

Stages the program comprised of:

1. Literature Review
- Creative and Participatory Design
- Plastered-Bamboo Design

2. Participatory Design in Kediri
- Socialization for Plastered - Bamboo Design with 1:1 Scale Mock-up
- Program Set-up
- Participatory Rural Appraisal
- Participatory Design Workshop

3. Participatory Construction in Kediri
- Fund-Raising
- Development of Integrated Communal Bathing-Washing – Toilet – Water Tank Facility with Plastered – Bamboo Construction.

Firstly, the literature study on creative and participatory design as well as plastered - bamboo design was conducted.

The Participatory Design process in Kediri comprised 4 stages as mentioned above. Socialization of Plastered – Bamboo Design was conducted using 1:1 Mock-up Plastered - Bamboo Panel. The panel was prepared in Surabaya. After program set-up between Petra team and Jatiwekas people, a participatory rural appraisal survey and participatory design workshop were conducted.

Based on the workshop, the integrated bathing - washing – toilet – water tank facility was designed by Petra Team.

Fourthly, Participatory Construction would be conducted in Kediri. This stage is still in the process because of limited capacity of Petra and community to fund the construction. This stage would be completed in December 2013.

III. LITERATURE REVIEW

Yudelson, J., (2009) highlighted that an integrated design can create the significant design innovations and cost saving. Client and project managers must be committed to the integrated design team constantly reminded to adhere to this system. [3]

Bill Reed (2005 & 2006), quoted in Yudelson, J., (2009) revealed the importance of using charrettes (with design) to change the behaviour of a team of designers. In his view, integrative design is intended to create a creative, systemic thinking and innovation in design. Therefore, a roadmap (road map) how each party can contribute in the process. [4]

Reed (2005 & 2006) defines the various elements of the integrative design:

- clients who are decision-makers, as well as the members of the design team,
- stakeholders and the design team should talk about expectations and goals in common design,
- the client and design team leader must choose a winner - a winner that can encourage hope and purpose,
- system design with an iterative process in the pre-design and stage - stage schematic,
- the design team must be committed to implement it until the construction phase is over,
- projects must be supervised to ensure that all systems are working in accordance with the initial design, monitoring and maintenance required to achieve project objectives.

Conclusively, mental change is needed for designer who works in a linear manner. The change of mind set should make designers to consider interconnected and mutually influence the system. This is consistent with Integrative Sustainable Design by 7Group and Reed, B., (2011). [5]

The plastered – bamboo design were applied in several projects. The house - Dutch house in the 1900s in Jatiroto, Central Java and Housing Gempol, Bandung, West Java showed resilience of the design according to Widyowijatnoko, A. (1999).[6] Secondly, the research-action by Dr. Ing. Widyowijatnoko, A., Dr. Faisal, B., and Mustakim produced variety of plastered - bamboo projects in the Pasir Impun House, Bandung, Earthquake – Victim Home, in Sukabumi; Community Learning Center (PKBM) Jatinangor, Sumedang, and Fishing Community Center in Nagalawan, North Sumatra. [7]

In fact, Dr.Ing. Widyowijatnoko, A. (2008) applied a creative plastered – bamboo prefabrication house design. In the research action, plastered bamboo design was found sustainable because creating a potential local economic development in urban areas, and solution for affordable housing for low-income residents. [8]

A variety of researches in the field of processing and preservation of bamboo have been carried out by the Environmental Bamboo Foundation and LIPI; besides that there were researches on plastered - bamboo application by Muhammadiyah University of Surakarta, Ir. Haryoto and Prof. Dr. Ir Morisco for building elements such as composite panels, water tank and roof. [9]

Meanwhile, the participatory design was applied in the redevelopment projects in Indonesia, such as Diwai Makam Sub-Village, Lambaro Skep, Banda Aceh, Aceh, Indonesia. Because located 2 km from the beach, this Sub-village suffered total destruction by the tsunami on December 26, 2004. A hundred and four homes were damaged and 50% of the population died.

To restore the lives of the people, a participatory re-planning and re-design was proposed. The activity was facilitated by association of NGOs consisting of ASPEK (Association of Housing Cooperative), UN-HABITAT, USAID, and the REACT URDI Indonesian Institute of Architects. The project was found need longer time but the project was found more sustainable because it accepted by the citizens. And it can be seen how effective integrative design in conventional building design process. [10]

IV. DISCUSSION

Recognising the various plastered - bamboo technology and creative - participatory design, an integrated bathing - washing – toilet – water tank facility was proposed in 3 major steps as described below:

A. Participatory Design in Kediri

Socialization plastered - bamboo design was conducted using a 1:1 scale mock-up, considering initial rejection of the people to the technology in the initial meeting. The 1:1 scale prototype was constructed in Petra Campus in Surabaya. Several steps of the plastered – bamboo construction process were documented such as:

1. Bamboo Harvesting and Splitting
2. Material Purchasing
3. Natural Bamboo Preservation

3b. Chemical Bamboo Preservation

4. Bamboo Blades Weaving
5. Simple Reinforcement

5b. Foundation Laying

6. Bamboo Panel Erection and Set-up
7. Plastering (Both Sides)
8. Column and Beam Plastering
9. Finishing

9b. Roof Construction

The Process was described in the Figure 1.

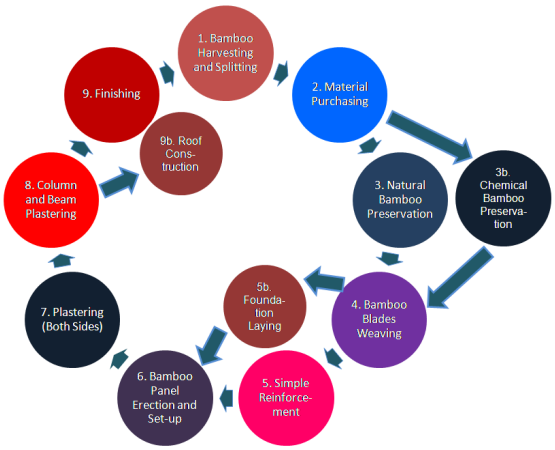

Figure 1. Plastered - Bamboo Construction Process Sources: http://www.bamboocentral.org/PDF_files/MODUL_PELATIHAN_MABUTER.pdf and visualised by Tanuwidjaja, 2013.

In the project, The Bambusa arundinacea (Retz.) Wild or Thorny Bamboo or “Bambu Ori" was chosen because the species is abundantly available in East Java. [11]

The ideal material for the plastered – bamboo panel were bamboo culms with diameter of 10-15 cm, 3-5 years old, in good condition and harvested 20 cm above the ground during the dry season. The bamboo culms used were only the 4-5 meters from the roots for weaving easiness (Garland, L., 2005). [12]

The bamboo culms cutting were conducted with a sharp saw according to the size of the panel. The module of plastered - bamboo panel was 50 cm x 80 cm for compactness. Then, 10 - cm - diameters - bamboo culms were split into two parts for stronger columns and beams. Furthermore, several bamboo culms were splitted to be 2 to 3cm - width - bamboo blades for the panel.

For constructing the 50 cm - by - 80 cm - plastered - bamboo module, several materials were needed such as:

- 1 sacks of portland cement (PC)
- 3 bags of coarse sand
- steel reinforcement and steel wire

The bamboo preservation of this experiment involved the borax - and - boric - acid - immersion technique. Understanding the difficult supply of the chemicals and non environmentally friendly impact, the technique was not socialized. Therefore, naturally - 3 - months - bamboo – immersion– technique was suggested. The bamboo culms had to be soaked in flowing water and kept under water. And later on, they need to be dried a week in the shades. [13]

Several equipments were prepared such as machetes, drill, wooden hammer (*ganden*), hammer, sieve, shovel, trowel, putty knife, a bucket and a hose.

Once preserved, the bamboo blades were woven to produce bamboo web or "pethek". The blades were positioned side by side horizontally, while the they were positioned 25 cm one to another vertically (Widyowijatnoko, A., 1999).[14] To make the web stable the end of the outer blades were bond with steel wires. To further stabilise the web, columns and beams were added with drilling and steel - wire - fastening. To reinforce the panel, 8 - mm - diameter reinforcing steel stirrups were installed 25 cm one from another.

After the panel assembled, plastering process was conducted. Widyowijatnoko,A.,(1999) recommended plaster mixture of 1 PC: 5 sand.[15] But to produce a better quality, a plaster mixture of 1 PC: 3 coarse sand without soil. From the experiments, it was found that Gresik PC (Semen Gresik) produced the best results.

After the plaster dried in 2 days, the bamboo columns and beams were also covered by the similar plaster. The plaster’s drying process took about 2 days. Spraying adequate water was needed during the process to reduce possible cracks. Furthermore, a finishing was done with mixture of cement and water. The cement was dissolved in small account into the water resulting thick mixture.

To convince the people on the construction method, the 1:1 scale plastered bamboo panel mock-up was transported to Jatiwekas Sub-village, Kediri regency. Furthermore, socialization and training plastered - bamboo design were conducted in the Village for five interested people. Training conducted for several stages such as bamboo harvesting, bamboo splitting, bamboo blades weaving, simple reinforcement and installation of columns and beams. Meanwhile of plastering was continued by the people independently because of time constraints. And the people were amazed on the technology and accepted the technology.

After that, Program Set-up was conducted to initiate the creative - participatory design for integrated bathing - washing – toilet – water tank facility. The people agreed that need of the facility to be cost effective, using plastered bamboo material. The process was fulfilled in January 2012.

The Participatory Villages Survey was conducted independently by Jatiwekas people. The step was made to find the households’ groups needing of facility and their priorities. And several the alternative locations of Integrated Bathing - Washing – Toilet – Water Tank Facility were found. And this was carried out in February - March 2012.

A Participatory Design Workshop was executed in March 2012. Design Workshop discussed detail design of Integrated Bathing - Washing – Toilet – Water Tank Facility to be easy to clean and sustainable. The selected location of the facility was determined.

The integrated bathing - washing – toilet – water tank facility was designed with 1.6 - meters - plastered - bamboo walls and roof. It adopted the bathing behaviour of Kediri village people which enjoy the fresh mountain air. The simple septic tanks were also prepared in the facility. Furthermore, the water tanks would in higher position to facilitate the distribution of clean water for several uses. The water tank would be supplied from the water pipelines from the mountainous region. Besides

bathing and toilet, washing and public taps were provided for local people.

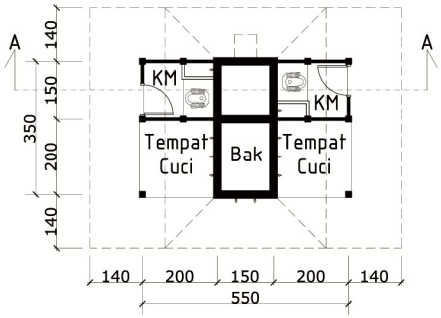

Figure 2. The Plan of Integrated Bathing - Washing – Toilet – Water Tank Facility.
Sources: Tanuwidjaja, 2013.

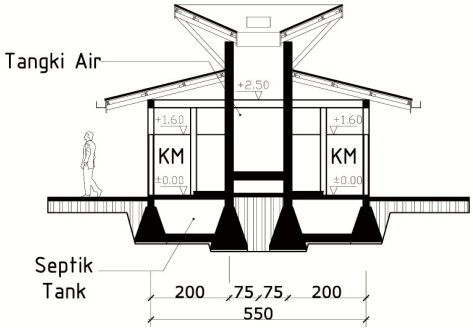

Figure 3. The Section of Integrated Bathing - Washing – Toilet – Water Tank Facility.
Sources: Tanuwidjaja, 2013

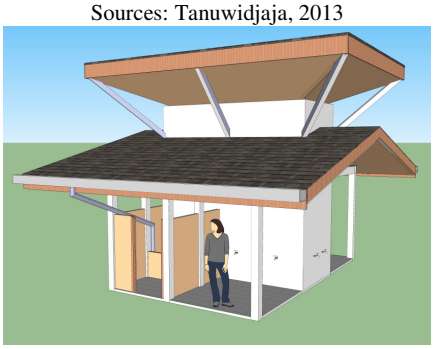

Figure 4. the Perspective of Integrated Bathing - Washing – Toilet – Water Tank Facility.
Sources: Tanuwidjaja, 2013.

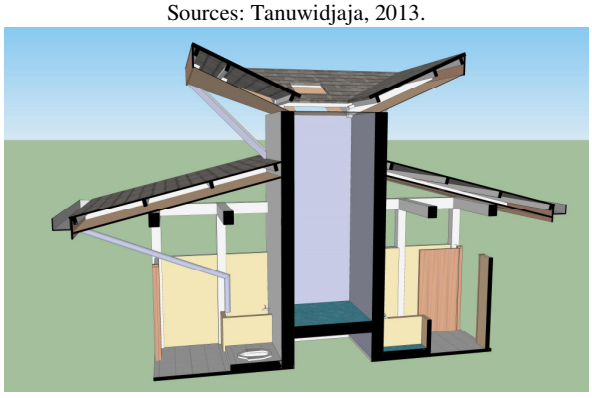

Figure 5. the Sectional Perspective of Integrated Bathing - Washing – Toilet – Water Tank Facility.
Sources: Tanuwidjaja, 2013.

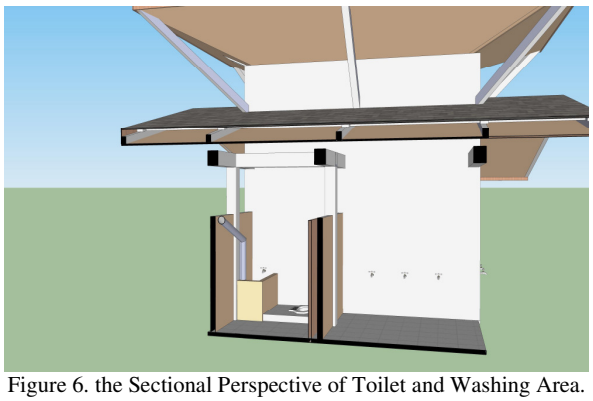

Figure 6. the Sectional Perspective of Toilet and Washing Area.
Sources: Tanuwidjaja, 2013.

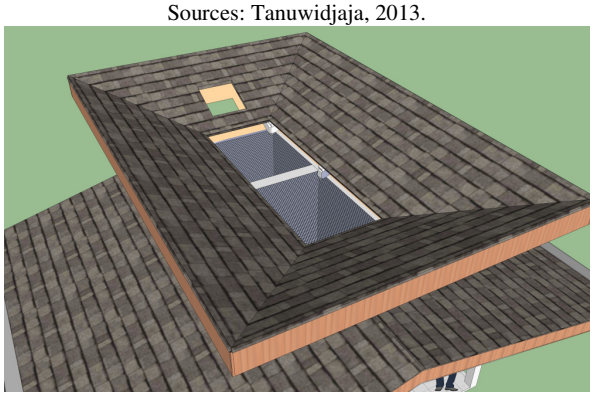

Figure 7. the Perspective of Water Collection Roof and Filter in the Integrated Bathing - Washing – Toilet – Water Tank Facility.
Sources: Tanuwidjaja, 2013.

B. Participatory Construction in Kediri

After reaching agreed design at the workshop, the fund raising as well as participatory construction would be conducted. Currently, the construction was not started yet because of limited funding from Petra and the local people. The process would involve the local bamboo artisans, ordinary people, local government and experts from the Petra University.

V. CONCLUSION

Creative and sustainable design could be achieved with plastered - bamboo creative eco-design because of the abundant bamboo resources and bamboo craftsmen in Kediri area, Jatiwekas Sub-Village.

The need of the Jatiwekas Sub-Village Community for integrated communal bathing-washing – toilet – water tank facility construction was found crucial. The program involved socialisation and training in the village, participatory village survey and participatory design, facilitated by the Petra University Team.

To generate more creativity in the village, the socialisation plastered - bamboo technology and design

was conducted using a 1:1 scale mock-up. The method was found effective but also costly. The 10 millions rupiahs of program cost was supported by Green Impact Indo, Integrated Urban, Drainage & Environmental Planning & Design Consultant. But still the success story of the process could be replicated in generating more creativity in the rural context.

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