
Bamboo construction : Qualitative indicators for housing - Case study in Bali, Indonesia

Auteur : Mertens, Audrey

Promoteur(s) : Elsen, Catherine; Franssen, Jean-Marc

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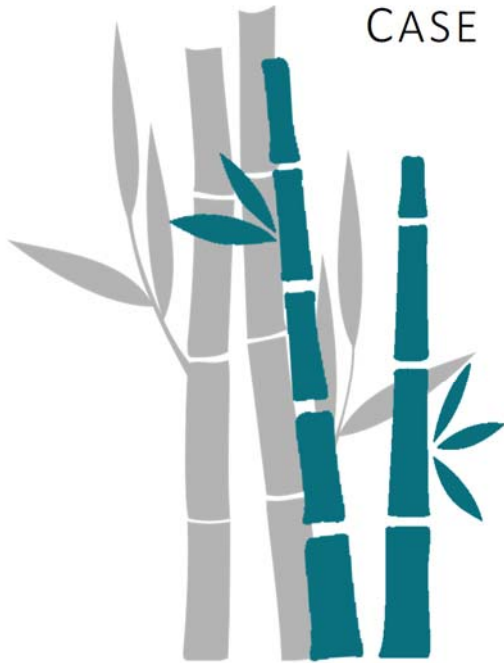
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BAMBOO CONSTRUCTION

QUALITATIVE INDICATORS FOR HOUSING CASE STUDY IN BALI, INDONESIA



Master Thesis

in order to obtain a master degree in
Engineering and Architecture
by **Audrey MERTENS**

Promoter **Catherine ELSÉN**

Co-promoter **Jean-Marc FRANSSEN**

Jury members S. REITER

J.-M. BLEUS

F. COURTEJOIE

BAMBOO CONSTRUCTION

QUALITATIVE INDICATORS FOR HOUSING

Case study in Bali, Indonesia

BY AUDREY MERTENS

UNIVERSITE DE LIEGE | 2018 – 2019

MASTER IN ENGINEERING AND ARCHITECTURE

ABSTRACT :

The present study consists of trying to understand what the bamboo has to offer as well as what its limits are. The location was chosen in **Bali**, Indonesia, because it is currently a place where we can find a high concentration of bamboo craftsmanship and bamboo factories. The material is locally available and a couple of emblematic buildings are located there.

Bamboo does not seem to be used much by the local Balinese population as a traditional construction material for housing. This master thesis confirms this statement and answers non-exhaustively why.

Furthermore, it seeks to **evaluate the perception** Balinese people have of bamboo construction, particularly for **housing**. In order to do so, we establish **qualitative indicators** as guidelines for the evaluation of the perception of bamboo housing.

The methods we choose to learn about the Balinese people's perception are the questionnaire survey, the in-depth interview and the commented walk.

The first one, the 24-question-**survey**, aims at a large public and got 57 participants. It collects data on the **common materials** used in Bali, the ideal material participants would choose for a new building and then evaluated the **perception of bamboo** under various angles.

The second method, the **in-depth interview** targets two small samples: 3 **expert actors** in bamboo construction, each one in their own way, and a sample of 4 **various chosen profiles** for an *a priori* experiment.

The experts sample includes a bamboo **structural engineer**, a bamboo **architect** and a bamboo **house owner**. Each one of them brings an overview of their domain regarding bamboo. This work also benefits of another bamboo expert's opinion: **Elora Hardy** agreed that we include one of her speeches in the present study. Thus she broaden the results with her experience.

The last method, the **commented walk**, is an ethnological approach consisting of collecting the users' on-site comments. It aims to capture aspects of the sensory perception. It was conducted with the same sample as the in-depth interview *a priori* of the 4 chosen participants. This method was implemented in order to retrieve some sensory perception indicators from the participants.

The following **indicators** came out of these experiments: the sociocultural context, perceived costs of a bamboo building, perceived lifespan of a bamboo building, perceived safety and flammability of a bamboo building, local availability of the material, perceived sustainability of the material, sensory perception in bamboo spaces, maintenance of bamboo buildings, lack of airtightness, and finally creativity, beauty and originality created by the use of bamboo.

Each of these indicators brought up an aspect of **how bamboo is perceived** and whether or not it is **accepted as suitable for housing**.

This master thesis could be used as a ground of reflexion for architects or administration members wishing to support bamboo projects in tropical regions.

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Of course, everybody in Bali who participated in the study, especially Chiko, Ade, Devi, Ayu, Ngurah and Putra have my gratitude. The study would not have been possible without their support.

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Finally, I would like to thank all my classmates whose participation at this university journey has given me such unforgettable memories.

FOREWORD

We are at a time in human history when climate changes and environmental issues should be a matter of primary concern as the future of many species, fauna and flora, is at stake. The construction sector counts amongst the most polluting industries across the world. As the future generation of building trades, we should be aware of the impact we are going to have on our surroundings.

In order to build sustainable housing and buildings in general, one factor we should not leave out is whether or not the users of the edifice will get a grip on the designed space. In architecture, the user-centred approaches are slowly challenging the traditional mindsets that usually place the architects as almighty artists. Thus connecting the designers and the users, asking them about their opinion on possible material for their home, was something that seemed crucial to me.

In western culture, through large mass-communication media such as the TED talks (Technology, Entertainment and Design talks) and fancy exhibition buildings, bamboo is being advertised and largely promoted. But whilst travelling in Asia, I observed very few remaining vernacular constructions in this material and local people did not seem fond of bamboo as a construction or structural element. Although from my point of view, the real challenge would be to promote bamboo construction for local populations – that is, not only for touristic buildings but also for housing. This being a scientific dissertation, the research will be oriented towards a vision as objective as possible.

CONTENT

| | |
|---|----|
| Table of figures | 9 |
| Chapter I – Introduction | 11 |
| 1.1. Problematic..... | 11 |
| 1.2. Focus and Limits..... | 12 |
| 1.3. Reader’s Handbook..... | 13 |
| Chapter II – State of the art..... | 14 |
| 2.1. Bamboo Architectural Engineering and Construction..... | 15 |
| 2.1.1. Temporary Buildings | 16 |
| 2.1.2. Emblematic Buildings..... | 16 |
| 2.1.3. Personal experience with bamboo | 18 |
| 2.2. Bamboo species suitable for construction | 22 |
| 2.3. Treatments..... | 23 |
| 2.4. Mechanical properties | 29 |
| 2.4.1. Characteristic strength values | 29 |
| 2.4.2. Calculation of design values..... | 31 |
| 2.4.3. Buckling | 32 |
| 2.4.4. Serviceability limit state (SLS) | 32 |
| 2.4.5. Foundations | 32 |
| 2.4.6. Connexions..... | 32 |
| 2.4.7. Engineered bamboo elements..... | 33 |
| 2.4.8. Literature gaps in mechanical properties | 34 |
| 2.5. Balinese Context | 35 |
| 2.5.1. Bamboo Architecture in Bali | 35 |
| 2.5.2. Geographic and Demographic context | 37 |
| 2.5.3. Balinese traditional architecture | 37 |
| 2.5.4. Emergence context | 39 |
| 2.6. Origin of the research | 40 |
| 2.6.1. Research questions | 40 |
| 2.6.2. Acceptability | 40 |
| 2.6.3. Perception..... | 41 |
| 2.6.4. Further possible indicators | 43 |
| Chapter III – Methodology..... | 44 |
| 3.1. Survey | 45 |

| | |
|--|----|
| 3.1.1. State-of-the-art | 45 |
| 3.1.2. Experimental protocol | 46 |
| 3.1.3. Data processing..... | 47 |
| 3.2. In-depth Interview | 47 |
| 3.2.1. State-of-the-art | 47 |
| 3.2.2. Experimental protocol | 49 |
| 3.2.3. Data processing..... | 51 |
| 3.3. Commented Walk | 52 |
| 3.3.1. State-of-the-art | 52 |
| 3.3.2. Experimental protocol | 54 |
| 3.3.3. Data processing..... | 56 |
| Chapter IV – Results..... | 58 |
| 4.1. Survey | 58 |
| 4.1.1. Representativeness of the sample studied..... | 58 |
| 4.1.2. Common construction materials | 61 |
| 4.1.3. Perception <i>a priori</i> of bamboo as a construction material for housing..... | 62 |
| 4.1.4. Key topics addressed | 68 |
| 4.2. In-depth interviews <i>a priori</i> | 70 |
| 4.2.1. In-depth interview of Ayu Simpani | 70 |
| 4.2.2. In-depth interview of Ade Parmitha | 72 |
| 4.2.3. In-depth interview of Devi Mariani..... | 74 |
| 4.2.4. In-depth interview of Ngurah Widi..... | 75 |
| 4.3. Commented walk..... | 77 |
| 4.3.1. Commented walk of Ayu..... | 78 |
| 4.3.2. Commented walk of Ade | 78 |
| 4.3.3. Commented walk of Devi..... | 79 |
| 4.3.4. Commented walk of Ngurah | 80 |
| 4.4. In-depth interviews <i>a posteriori</i> | 82 |
| 4.4.1. In-depth interview of Ayu | 82 |
| 4.4.2. In-depth interview of Ade..... | 82 |
| 4.4.3. In-depth interview of Devi | 83 |
| 4.4.4. In-depth interview of Ngurah | 84 |
| 4.5. Experts In-depth interviews and conference | 85 |
| 4.5.1. In-depth interview of Chiko Wirahadi Purnawan, Architect | 85 |

| | |
|---|-----|
| 4.5.2. In-depth interview of Thierry Cayot, Bamboo structural engineer | 87 |
| 4.5.3. In-depth interview of Putra, owner of a bamboo house | 89 |
| 4.5.4. Conference by Elora Hardy, Leader of Ibuku team, bamboo designers | 90 |
| Chapter V – Discussions | 93 |
| 5.1. Interpretation of the results | 93 |
| 5.2. Biases and limits | 100 |
| 5.3. Research opportunities | 102 |
| 5.4. IBCC outcome | 103 |
| Chapter VI – Conclusions | 107 |
| Bibliography | 109 |
| Webography | 113 |
| Image credits | 115 |
| Appendices | 116 |
| A. Survey form – English | 116 |
| B. Survey form – Bahasa Indonesia | 122 |
| C. Interview grids | 128 |
| C.1. In-depth interviews of experts | 128 |
| C.2. In-depth interviews <i>a priori</i> | 128 |
| C.3. Photo-elicitation images | 129 |
| C.4. Commented walks | 134 |
| C.5. In-depth interviews <i>a posteriori</i> | 135 |
| D. Transcript 1 – Interview of Chiko Wirahadi Purnawan part 1 | 135 |
| E. Transcript 2– Interview of Chiko Wirahadi Purnawan part 2 | 139 |
| F. Transcript 3 – Interview of Thierry Cayot, founder of Asali Bali | 141 |
| G. Transcript 4 – Interview of Putra, owner of a bamboo house in Bali, Indonesia | 147 |
| H. Transcript 5 – Conference by Elora Hardy on the 16/04/19, in Seminyak, Bali, Indonesia | 152 |
| I. Transcript 6 – In-depth interview of Ayu Simpani, accouter at Asali Bali | 157 |
| J. Transcript 7 – Commented walk of Ayu | 163 |
| K. Transcript 8 – Interview post commented walk of Ayu | 167 |
| L. Transcript 9 – In-depth interview of Ade Parmitha, student | 169 |

| | | |
|----|--|-----|
| M. | Transcript 10 – Commented walk of Ade | 175 |
| N. | Transcript 11 – Interview post commented walk of Ade | 180 |
| O. | Transcript 12 – In-depth interview of Devi Mariani, employee | 181 |
| P. | Transcript 13 – Commented walk of Devi..... | 186 |
| Q. | Transcript 14 – Interview post commented walk of Devi..... | 191 |
| R. | Transcript 15 – In-depth interview of Ngurah Widi, retired..... | 193 |
| S. | Transcript 16 – Commented walk of Ngurah..... | 197 |
| T. | IBCC Contest – House Loti Project | 206 |
| U. | Connexion examples | 212 |
| V. | Further data collected..... | 215 |
| | V.1. Additional diagrams..... | 215 |
| | V.2. Pictures of the commented-walk buildings | 216 |

TABLE OF FIGURES

| | |
|---|------------------------------------|
| FIGURE 1 - SCHEME DESCRIBING THE STATE-OF-THE-ART STAGES..... | 14 |
| FIGURE 2 - TRADITIONAL BAHAY KUBO, PHILIPPINES | 15 |
| FIGURE 3 - TRADITIONAL CONSTRUCTION IN BURMA, MYAMAR..... | 15 |
| FIGURE 4 - GERMAN-CHINESE HOUSE, SHANGHAI, BY MARKUS HEINS DORFF..... | 15 |
| FIGURE 5 - GREEN SCHOOL, BALI, BY IBUKU | 15 |
| FIGURE 6 - THE GREEN LADDER, AUSTRALIA 2016, VTN ARCHITECTS..... | 16 |
| FIGURE 7 & FIGURE 8 - GREAT BAMBOO WALL HOUSE, BEIJING 2002, BY KENGO KUMA | 17 |
| FIGURE 9 - H&P'S BAMBOO HOME PROTOTYPE, VIEW FROM THE OUTSIDE | 17 |
| FIGURE 10 - H&P'S BAMBOO HOME, VIEW FROM THE INSIDE | 17 |
| FIGURE 11 - BAMBOO HOME, VIETNAM 2013, H&P ARCHITECTS | 18 |
| FIGURE 12 - WIND SIMULATION : GENERATING A PRESSURE MAP, ASALI BALI | 19 |
| FIGURE 13 - RESULTS OF CALCULATIONS : BENDING MOMENT IN BAMBOO ARCHES UNDER THEIR OWN WEIGHT, ASALI BALI..... | 20 |
| FIGURE 14 - RESULTS OF CALCULATIONS : EXAGGERATED DEFORMATION UNDER A SINGLE POINT LOAD, ASALI BALI..... | 20 |
| FIGURE 15 - LEARNING ABOUT FULL-BAMBOO CONNEXIONS AT ASALI BALI, PERSONAL COLLECTION OF PHOTOS..... | 20 |
| FIGURE 16 - BAMBOO CRAFTSMAN GIVING THE INSTRUCTIONS, PERSONAL COLLECTION OF PHOTOS | 20 |
| FIGURE 17 - BAMBOO RESTAURANT BALI, PERSONAL COLLECTION OF PHOTOS | 21 |
| FIGURE 18 - BAMBOO HOTEL UBUD, PERSONAL COLLECTION OF PHOTOS..... | 21 |
| FIGURE 19 - DISTRIBUTION MAP OF BAMBUSOIDEAE (BROTO, 2014) | 22 |
| FIGURE 20 - BAMBOO PETUNG, BAMBOO U..... | 22 |
| FIGURE 21 - SCHEME OF A CULM (KAMINSKI, LAWRENCE & TRUJILLO, 2016) | 23 |
| FIGURE 22 - POWDER BEETLE ATTACK, ASALI BALI | 24 |
| FIGURE 23 - TERMITE DAMAGE ON A BAMBOO POLE, ASALI BALI | 24 |
| FIGURE 24 - FUNGUS AND ROT ATTACK, ASALI BALI..... | 25 |
| FIGURE 25 - PUNCTURE OF NODAL DIAPHRAGMS..... | 27 |
| FIGURE 26 - VERTICAL SOAK DIFFUSION TREATMENT TOWER | 27 |
| FIGURE 27 - BAMBOO SCRIMBER GENERAL MANUFACTURING PROCESS (SHARMA, GATÓO, BOCK & RAMAGE DRANSFIELD, 2015) | 33 |
| FIGURE 28 - LAMINATED BAMBOO GENERAL MANUFACTURING PROCESS (SHARMA ET AL., 2015)..... | 33 |
| FIGURE 29 - LAMINATED BAMBOO MANUFACTURING PROCESS (SHARMA ET AL., 2015)..... | 33 |
| FIGURE 30 - SHARMA SPRINGS RESIDENCE, GREEN VILLAGE, BALI, BY IBUKU | 35 |
| FIGURE 31 - FIVELEMENTS PROJECT PURI AHIMSA, BALI, BY ARTE ARCHITECT..... | 36 |
| FIGURE 32 - FINNS BEACH CLUB, BALI, BY PBM ARCHITECTURE AND PROJECT MANAGEMENT | 36 |
| FIGURE 33 - BALI MAP, SITUATION OF EMBLEMATIC BAMBOO BUILDINGS, CREATED WITH GOOGLE MY MAPS..... | 36 |
| FIGURE 34 - BIRD'S EYE VIEW OF A TYPICAL RURAL DOMESTIC COMPOUND (AVIANTI, 2014)..... | 38 |
| FIGURE 35 - BAMBOO HOUSE INSPIRED BY TRADITIONAL RICE BARNS, PERSONAL COLLECTION OF PHOTOS..... | 39 |
| FIGURE 36 - SCHEME OF THE 9M ² STORAGE PAVILION VISITED DURING THE COMMENTED WALKS | ERREUR ! SIGNET NON DEFINI. |
| FIGURE 37 - GROUND FLOOR OF THE HOUSE VISITED DURING THE COMMENTED WALKS | 55 |
| FIGURE 38 - MEZZANINE FLOOR OF THE HOUSE VISITED DURING THE COMMENTED WALKS..... | 55 |
| FIGURE 39 - DISTRICTS OF BALINESE PARTICIPANTS | 59 |
| FIGURE 40 - BALI, PROVINCE IN INDONESIA, DENSITY, CITY POPULATION.INFO | 59 |
| FIGURE 41 - AGE PYRAMID, POPULATION IN 2018 IN BALI, BY THE INDONESIAN CENTRAL BODY OF STATISTICS..... | 60 |
| FIGURE 42 - RANGE OF AGES OF THE PARTICIPANTS IN THE QUESTIONNAIRE | 60 |

| | |
|--|-----|
| FIGURE 43 - PERCENTAGE OF PEOPLE SELECTING MATERIALS COMPOSING THEIR HOME | 61 |
| FIGURE 44 - PERCENTAGE OF PEOPLE SELECTING THE MATERIALS COMPOSING THEIR NEIGHBOURS' HOUSES | 61 |
| FIGURE 45 - PERCENTAGE OF PEOPLE SELECTING MATERIALS FOR THEIR IDEAL NEW BUILDING | 61 |
| FIGURE 46 - PERCENTAGES OF PEOPLE ANSWERING THE QUESTION..... | 62 |
| FIGURE 47 - ANSWERS TO THE QUESTION AS A FUNCTION OF THE AGE OF THE PARTICIPANTS | 63 |
| FIGURE 48 - ANSWERS TO THE QUESTION AS A FUNCTION OF THE DISTRICT OF THE PARTICIPANTS | 64 |
| FIGURE 49 - PERCENTAGES OF PEOPLE, REGARDING THE COST OF BAMBOO CONSTRUCTIONS..... | 64 |
| FIGURE 50 - PERCEPTION OF THE COST OF BAMBOO CONSTRUCTION AS A FUNCTION OF THE AGE OF THE PARTICIPANTS..... | 65 |
| FIGURE 51 - PERCEPTION OF THE COST OF BAMBOO CONSTRUCTION AS A FUNCTION OF THE OCCUPATION OF THE PARTICIPANTS..... | 66 |
| FIGURE 52 - PERCENTAGE OF PEOPLE REGARDING THE PERCEIVED LIFESPAN OF A BAMBOO HOUSE | 66 |
| FIGURE 53 - PERCEPTION OF THE LIFESPAN OF A BAMBOO HOUSE AS A FUNCTION OF THE AGE OF THE PARTICIPANTS | 67 |
| FIGURE 54 - PROPORTION FOR EACH LIFESPAN RANG ANSWERS OF PEOPLE KNOWING S.O. WHO OWNS A BAMBOO HOUSE VS. NOT | 67 |
| FIGURE 55 - WORD CLOUD OF THE UTTERANCES | 68 |
| FIGURE 56 - OCCURRENCE OF UTTERANCES TARGETING KEY TOPICS FOR QUALITATIVE INDICATORS FOR BAMBOO HOUSING, COLLECTED THROUGH THE WHOLE QUESTIONNAIRE | 69 |
| FIGURE 57 - HOUSE LOTI FOR THE IBCC 2019, PERSONAL COLLECTION OF PHOTOGRAPHS | 103 |
| FIGURE 58 - HOUSE LOTI, EXPLODED DIAGRAM OF COMPOSITION | 105 |
| FIGURE 59 - MOUNTING THE HOUSE LOTI PAVILION ON-SITE, PERSONAL COLLECTION OF PHOTOGRAPHS | 106 |

CHAPTER I – INTRODUCTION

1.1. PROBLEMATIC

Bamboo, a worldwide available material in tropical regions, has been used in construction for centuries in vernacular architecture. Whether it is Moso bamboo also known as *Phyllostachys edulis* or bamboo Petung, *Dendrocalamus asper*, whether it is used raw, treated, laminated or scrimberred (Sharma, Gatóo, Bock & Ramage Dransfield, 2015), the bamboo construction is a reliable option available on the market for small scale as well as monumental buildings in a variety of architectural styles and environments. Architects such as Vo Trong Nghia, Shigeru Ban (Fairs, 2014) or Simón Vélez (Kries, 2000) have been promoting it for years. The question here will be to evaluate under what conditions can the users appropriate these bamboo spaces given the contemporary stakes of devaluation of the material.

Bamboo construction, however, faces a harsh competition with concrete or steel although these materials have higher Embodied Energy values than bamboo (Dongwei, Hongwei & Yingjun, 2011). Even in parts of the world where concrete and brick are not locally produced and have to be imported, there does not seem to be any evidence that the construction sector is turning to environmentally friendly alternate construction options (Fitrianto, 2015). Bamboo especially seems to have acquired a negative connotation, as it is seen as a “poor men’s material”, ephemeral and of poor quality especially by the local communities (Nurdiah, 2016).

In Bali, as demographic pressure is increasing (World Population Review, 2019), the wealth of the island is ensured by a flourishing touristic sector, involving new constructions that are rising up at an impressively high rate. Concrete and brick seem to have more success than ever (Smith, 2018). These materials remain coveted despite their negative impact on the environment due to transport or recyclability, for instance.

The present study illustrates what bamboo has to offer as well as what its limits are. This research tries to express and actually observe the perception users have of bamboo construction. The research focuses on a small area as this is a master thesis. Thus the location was chosen in Indonesia, especially Bali, because it is currently a place where we can find a high concentration of bamboo craftsmanship and bamboo factories. The material is locally available and emblematic buildings are located there.

This thesis seeks to evaluate **the perception** that Balinese people have of bamboo construction, particularly of bamboo housing. In order to do so, we have to establish **qualitative indicators** as guidelines. Each of these indicators must bring up an aspect of the perception of bamboo buildings and whether or not they are accepted as suitable for housing or not by the Balinese population.

By indicator, we mean a quantitative or qualitative factor or variable that provides a simple and reliable means to reflect the changes connected to an intervention. Indicators are used in establishing guidelines for observation and evaluation. Qualitative indicators are about opinions and perceptions, in contrast with quantitative indicators which relate to amounts or quantities (Church & Rogers, 2006).

Then we want to discuss for each of these indicators what may encourage or discourage people from considering bamboo as a construction material for their homes.

In order to do so, we first want to get a grip on the material with the main lines of its characteristics. We also want to understand the context we are in and define clearly the notions used.

We also need to explore various ways of framing indicators. In this case, we are using surveys, interviews and commented walks. Crossing data and comparing results can lead to validating some indicators as well as confronting different results.

1.2. FOCUS AND LIMITS

The general focus of the investigation can be seen in two phases: first, it is important to discern bamboo's strengths and weaknesses, to get in touch with this unfamiliar material and to gather knowledge and experience with the material. Then, as to understand if it could actually be an option considered by local populations, the stake is to get in contact with as many people as possible to gather their impressions over the material and see whether bamboo could be acceptable for housing. We believe such an investigation could benefit the fields of both engineering and architecture providing analytic keys to bamboo companies, architects and possibly the local authorities to open ways of rejuvenating this sustainable material (Nurdiah, 2016; Nripal Adhikary, 2014). The results could be applicable elsewhere, too.

The research does not consider every possible use of bamboo in construction. The focus is more specifically on its role as a structural element. Although bamboo seems widely accepted as flooring, wall cladding, decorating and furnishing material, here we ask the question if it is commonly seen as an option for the bearing structure. It is briefly considered for frameworks as well, even though that is not the main subject here.

We are not studying the earthquake resistance of bamboo building either, as this matter would require more time and research means. Bamboo can present various brittle failure modes (Kaminski, Lawrence, Trujillo, Feltham & Lòpez, 2016), nevertheless it seems to behave favourably in case of tremors (Kaminski, Coates, Lawrence & Aleman, 2015).

The focus is not on monumental bamboo structures nor on structural analysis. Readers should be aware that this master thesis is a prequel to introduce bamboo and acceptability levels of bamboo construction for housing.

In the context of a master thesis, the study is framed. Limits and boundaries are set, not to get lost in a too vast subject. Here, the opportunity to meet actors from the field of bamboo construction, such as members from Asali Bali and Ibuku, guided the choice to focus on the island of Bali, Indonesia.

1.3. READER'S HANDBOOK

To help get the major outlines of this essay, important highlights throughout the text, summing up or concluding a section or chapter, are **framed**. Keywords are written in **bold type faces**.

Chapter I mainly sums up the keys necessary to read and understand the following study. It warns the reader off what this thesis is really about and what one should not be expecting whilst reading this and it charts the conduct of this thesis.

Chapter II consists of a state-of-the-art about bamboo architecture and construction, also addressing characteristics of bamboo and treatment processes. In this chapter, an abstract of the Balinese situation on the matter is reported. Finally, it contains an explanation of the research questions we are trying to answer as well as defining what we mean by acceptability and perception.

Chapter III describes the methodology used to try and answer the incumbent research questions and broadens the methods chosen for this purpose. It is also about framing the way the collected data are used. The three methods at issue are the questionnaire survey, the in-depth interview and the commented walk.

Chapter IV touches on the results of these experiments, firstly method by method, then crossing the data between the different ways they were collected.

Chapter V then interprets those results, analyses and discusses them, taking a step back to allow a critical point of view overall, regarding the process of the experiment as well as the results. It also suggests possible research opportunities emerging after this study.

Chapter VI finally concludes this master thesis, summing up the outlines of the process and results along with the outcomes of the interpretation of these. This gives closure to the dissertation and is followed by the Bibliography, Table of Figures and Appendices.

Appendices contain the survey forms, interview and commented walk handbooks with transcriptions of the experiments as well as the descriptive report of the INBAR Competition submission (cf. section 2.1.3). It also documents supplementary diagrams for the interested reader.

CHAPTER II – STATE OF THE ART

This chapter is built to ground the basis of this research. First, we start from observation in architectural reviews and books of existing bamboo constructions, in section 2.1: from famous bamboo edifices to temporary building examples.

We swept in some of the researcher's personal experience in section 2.1.3. with the material, leading to the construction of a pavilion.

Then, one might ask more details about the bamboo as a species and what kind of bamboo can be used in construction, in section 2.2.

These considerations then take us to wondering what processes does bamboo have to go through in order to be suitable for construction: this is answered in section 2.3.

To get a good grasp of the material, section 2.4 goes through the major characteristics of raw bamboo as a construction element and the usual connexion possibilities.

Section 2.5 then takes a step back to take a look at the context, e.g. Bali, its architecture and some of its geographic and demographic data.

Finally, the last section of this chapter formulates the research questions and specifies what we mean by notions such as acceptability and perception. These stages are represented in the figure below.

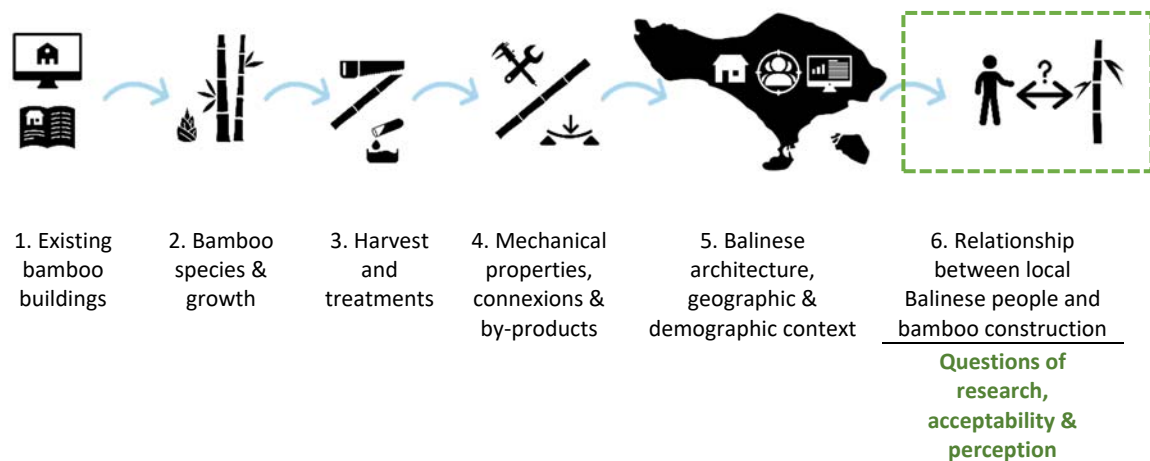


FIGURE 1 - SCHEME DESCRIBING THE STATE-OF-THE-ART STAGES

2.1. BAMBOO ARCHITECTURAL ENGINEERING AND CONSTRUCTION

Bamboo construction is usually well known for its application in traditional construction (Keeler, 1902), such as the buildings in Figure 2 and Figure 3, or for contemporary emblematic buildings such as the “German-Chinese House” at the Shanghai World Expo 2010 (Figure 4), by Markus Heinsdorff or the Green School in Bali (Figure 5), designed by John Hardy’s Indah Bamboo together with the Ibuku team in 2007 (Broto, McBride & Barros, 2014). Although most bamboo emblematic projects are temporary buildings, some bamboo projects designed to last are lately being built all around the world.



FIGURE 2 - TRADITIONAL BAHAY KUBO, PHILIPPINES



FIGURE 3 - TRADITIONAL CONSTRUCTION IN BURMA, MYAMAR

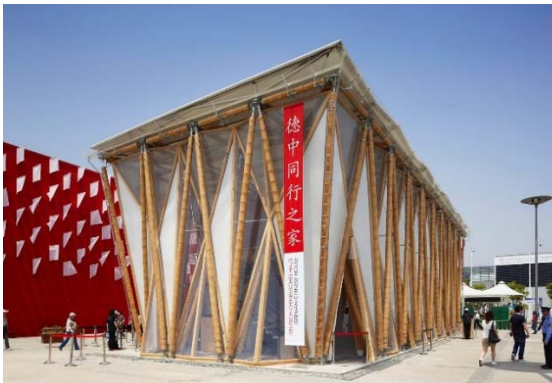


FIGURE 4 - GERMAN-CHINESE HOUSE, SHANGHAI, BY MARKUS HEINSDORFF



FIGURE 5 - GREEN SCHOOL, BALI, BY IBUKU

All of these examples take place in a tropical climate and in this case, more specifically in Asia. However, the first ones are significantly scantier and less represented in literature. The few traditional habitats described in bamboo are often **not very durable** (United States Geological Survey, 2012). Why is this? This will later on bring us to formulate the studied problematic.

We also note the advent of guides for auto-construction, edited by organisations such as *Humanitarian Bamboo* (2009) or CIBAM (Centro de Investigación de Bambú y Madera) together with the National University of Colombia (Hidalgo & Diroux, 2018), trying to **popularize** bamboo construction in the poorest villages of South-America and Asia. However, there does not seem to be any information pointing at an **acceptance** of these techniques by the targeted populations.

2.1.1. TEMPORARY BUILDINGS

Temporary buildings being developed as emergency prototypes are needed in some countries in the world, after natural disasters for instance. Thus construction techniques that can be applied fast in such cases is a matter which architects and engineers, such as INBAR¹ members, all around the world are looking into. In order for these initiatives to pay off, on site actors should be aware of the properties and construction techniques of bamboo construction.

Another type of temporary constructions such as pavilions for exhibitions are only built for a couple of weeks or months but still get good press and give an idea of the possibilities for bamboo as a construction material. In that range, VTN Architects led by Vo Trong Nghia designed a project called the “Green Ladder” (Figure 6) in 2016, for a three months exhibition at the main garden of the Library of Queensland, Australia (Hernández, 2016).



FIGURE 6 - THE GREEN LADDER, AUSTRALIA 2016, VTN ARCHITECTS

These showcase-buildings, while promoting the image of bamboo, increase awareness on bamboo construction being an alternative to common construction material. Nevertheless, these types of projects might reinforce the image of bamboo as a luxury product, inaccessible for low-cost housing, rather used for high range tourism buildings. This might create a **paradox** with the vision of the bamboo being “the poor man’s material”, as described by Nurdiah’s studies (2016). This double “personality” of the material is crucial further on in this research.

2.1.2. EMBLEMATIC BUILDINGS

Most of the state-of-the-art about emblematic buildings made of bamboo focuses on tourism or cultural infrastructures such as the Great Bamboo Wall House by

¹ International Bamboo and Rattan Organization.

Kengo Kuma built in Beijing in 2002 (Broto, McBride & Barros, 2014)(Figure 7 and Figure 8). These are the buildings that get advertised widely worldwide, promoting bamboo and slowly bringing curious architects to dig into bamboo construction techniques.



FIGURE 7 & FIGURE 8 - GREAT BAMBOO WALL HOUSE, BEIJING 2002, BY KENGO KUMA

Recently, architects are trying to open a new field for bamboo construction: low-cost sustainable housing. For example, low-cost bamboo house prototypes have been developed in Costa Rica since 2012 (Kaminski, Lawrence & Trujillo, 2016). We can also mention the prototype, here below in Figure 9 and Figure 10, for H&P's Bamboo Home that "reconceptualises vernacular technologies for the present day to create a simple and inventive flood-resistant dwelling" (The Architectural Review, 2014).



FIGURE 9 - H&P'S BAMBOO HOME PROTOTYPE, VIEW FROM THE OUTSIDE



FIGURE 10 - H&P'S BAMBOO HOME, VIEW FROM THE INSIDE

Whilst still being a trim construction, designed and detailed by a famous Vietnamese studio of architecture, this housing project still targets a population with a very low level of income. In their approach, the architects do not leave aside essential aspects of a qualitative and healthy architecture. With craftiness such as natural ventilation, aiming for a better air quality inside the house as well as a comfort of temperature, and rainwater harvesting, the thoughtful architecture of this prototype offers a real example of a good stunt for bamboo housing.

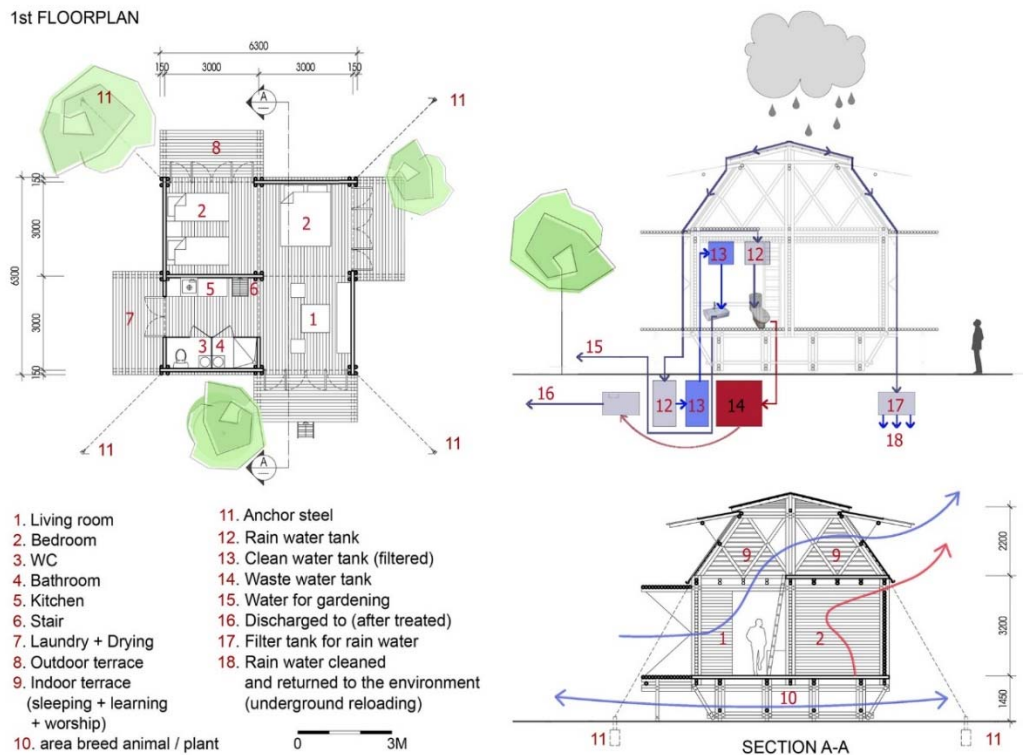


FIGURE 11 - BAMBOO HOME, VIETNAM 2013, H&P ARCHITECTS

This project is one of the rare contemporary examples of concept developed for housing, by architects aiming at a public with **lower means**. Now whether or not there might be a public for this kind of concept is yet to be determined. This is the field we will be interested in.

In the end, we have seen that luxury bamboo buildings are promoting bamboo constructions but there is little representation of these in the context of housing. This might be because newest technologies such as treatment of bamboo have not yet been acknowledged by the majority of people. However, this seems to be slowly changing.

Hence the question asked can be if bamboo is in fact "suitable for housing" according to the users. But above all, we interrogate the indicators pointing at this.

The focus in bamboo architecture has lately been turned mainly towards showcasing-buildings in tourism or cultural sectors. However, it is slowly shifting to functions targeting a rather fundamental need: **housing**.

2.1.3. PERSONAL EXPERIENCE WITH BAMBOO

Beside the theoretical grip on the material we are drafting, I feel that a serious researcher should be on the field and really be in touch with the material. I am therefore going to present two personal experiences that brought me to get a closer glimpse at the material.

This section is written, unlike the rest of this master thesis, from a very **subjective point of view** as it only describes a **personal experience**. Moreover, as it has led up to the actual construction of a pavilion building, I think it is worth pointing out.

3 DAY BAMBOO WORKSHOP

In April 2019, I had the opportunity to attend a three-day workshop in the engineering company Asali Bali which is specialized in bamboo construction. We were taught the basis of bamboo's structural behaviour with a condensed programme. Quentin Didier, an engineer student intern at Asali Bali, briefly told us about the semi-probabilistic approach used to take into account the diversity of each bamboo component in a model by considering, for each category of diameter, bamboo as a uniform hollow tube, with a fixed diameter and thickness, weaker than the weakest bamboo culm measured. Another interesting fact mentioned throughout the theoretical course was that, apart from roof cover and foundations, a full-bamboo design is possible.

They explained how they input the geometry of the bamboo structure, the mechanical properties of the variety of bamboo chosen, the cross-sections of the beams and loads (live loads, dead loads, wind and seismic loads) into Robot Structural Analysis Professional, a BIM-integrated² structural analysis software. The geometry of the tubular section is given by $D_{in} = 0,82 \times D_{out}$, where D_{in} is the inner diameter of the tube and D_{out} the known outer diameter.

The outputs are diagrams such as the ones in Figure 12 to Figure 14, the stresses in bars, deflections and displacements and the loads transferred to the foundations. For any possible combination of loads to which the building might be submitted, if the stresses, deflections and displacements do not exceed the limits imposed by standards, the structural design is considered valid.

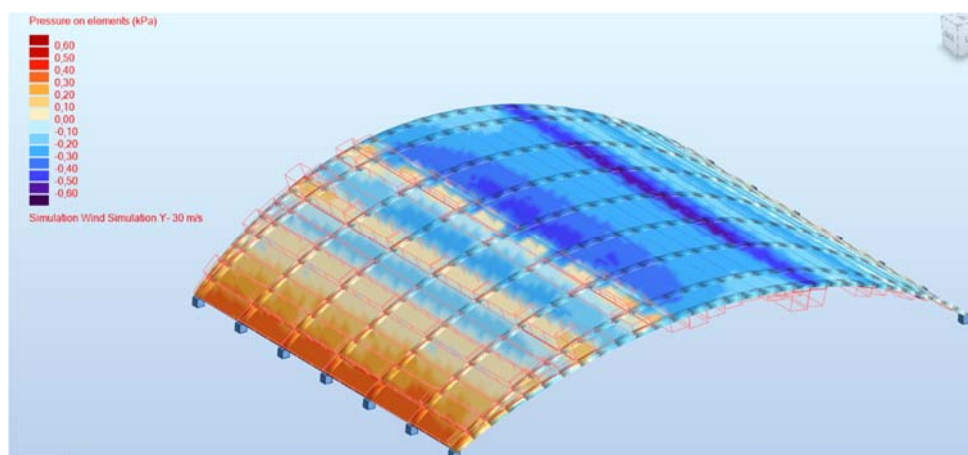


FIGURE 12 - WIND SIMULATION : GENERATING A PRESSURE MAP, ASALI BALI

² Building Information Modelling

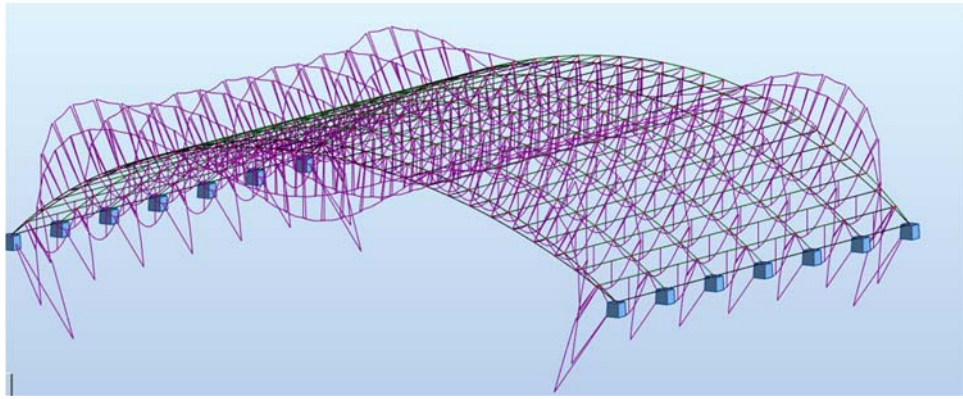


FIGURE 13 - RESULTS OF CALCULATIONS : BENDING MOMENT IN BAMBOO ARCHES UNDER THEIR OWN WEIGHT, ASALI BALI

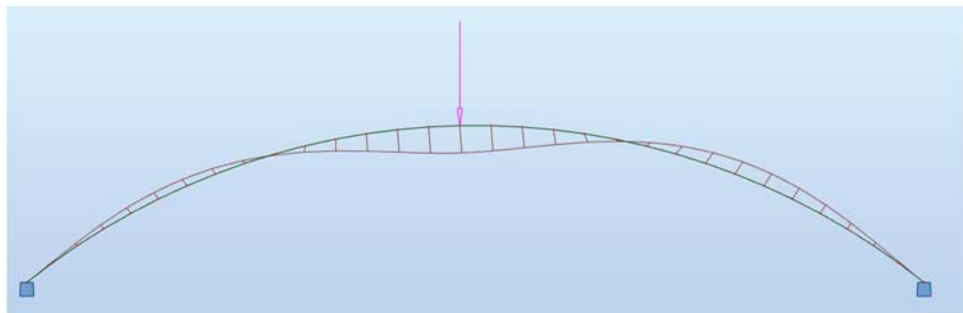


FIGURE 14 - RESULTS OF CALCULATIONS : EXAGGERATED DEFORMATION UNDER A SINGLE POINT LOAD, ASALI BALI

Then, we had a practical class to learn from the craftsmen how to hand-cut and carve bamboo for connections.



FIGURE 15 - LEARNING ABOUT FULL-BAMBOO CONNEXIONS AT ASALI BALI, PERSONAL COLLECTION OF PHOTOS



FIGURE 16 - BAMBOO CRAFTSMAN GIVING THE INSTRUCTIONS, PERSONAL COLLECTION OF PHOTOS

We later built a stool in order to apply those techniques. On the third day, the group went on-site to visit a couple of bamboo constructions.



FIGURE 17 - BAMBOO RESTAURANT BALI, PERSONAL COLLECTION OF PHOTOS



FIGURE 18 - BAMBOO HOTEL UBUD, PERSONAL COLLECTION OF PHOTOS

This workshop is organized by Asali Bali to **promote bamboo construction** for potential users. However, only **foreigners** participated, no Balinese people joined the classes. The targeted population, once again, does not seem to be the local population. Moreover, the visited buildings are essentially used for tourism or catering businesses.

INTERNATIONAL BAMBOO CONSTRUCTION COMPETITION

In June 2019, I submitted a project for the “International Bamboo Construction Competition 2019” (IBCC 2019, organized by INBAR) together with Fantine Fontaine (civil engineering student at the University of Liège, ULiège) and Chen Qi (architecture student at the University of the West of England UWE).

The architectural programme we were asked to design consisted of a multifunctional pavilion which could be used as a bar, a resting space, an office or for small storage. The plot given for the foundation was a square of 3 meter sides and cantilevers could take space up to 4 by 4 square metres. The theme of the contest was “blossom.” This theme inspired a dynamic design, being able to actually bloom: petals composing the walls of the closed flower can blossom into sun-shade panels and seats.

The full descriptive report submitted for the contest is available in Appendix T and the graphic panels can be found on the INBAR website (INBAR News, 2019).

The design process of this project took place in **parallel with the on-site research** for this master thesis. As the **qualitative indicators for housing** were emerging, they were, from my point of view, **essential to integrate in the design**. The present study therefore really influenced the conception of the pavilion. Studying the treatment techniques, properties of bamboo described further on in this chapter also contributed in creating a **solid design specifications brief** for the submission. All together both processes influenced each other.

In the **Discussions** of this master thesis (**Chapter V**), the follow-up of the contest and pictures of the construction are documented. The details of the descriptive report submitted for the selection phase of the competition are located in Appendix T.

2.2. BAMBOO SPECIES SUITABLE FOR CONSTRUCTION

“Although botanically not wood, the chemical composition of bamboo is almost an exact duplicate of wood with approximately the same proportions. As alluded to before, the main constituents of bamboo are cellulose, hemicellulose, lignin, and water” (Chan, 2012, pp. 6-7).

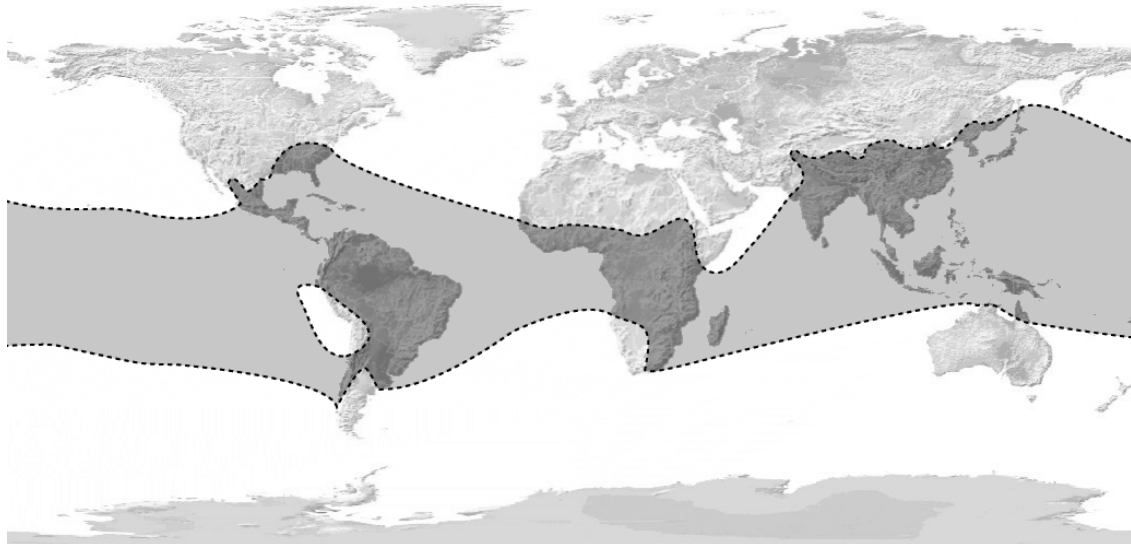


FIGURE 19 - DISTRIBUTION MAP OF BAMBUSOIDEAE (BROTO, 2014)

Bamboos, also called Bambusoideae, are a form of the tribe *Bambuseae* and can grow up to 25m in six months in tropical regions (Figure 19 - Distribution Map of Bambusoideae (Broto, 2014)). It is similar to grass but, unlike grass, all members possess similar anatomical features in the leaf blades, fusion cells and arm cells (Widjaja, 1995). Once fully grown, culms typically take three to five years to mature to full strength, during which they experience silification and lignification (Trujillo, 2007).



FIGURE 20 - BAMBOO PETUNG, BAMBOO U

There are about a thousand major species of bamboo belonging to almost eighty genera in the world. In South-East Asia, forty-five of these species are widely available and extensively used. They belong to eight genera: *Bambusa* Schreber, *Cephalostachyum*

Munro, *Dendrocalamus* Nees, *Gigantochloa* Kurz ex Munro, *Melocanna* Trin., *Phyllostachys* Sieb. & Zucc., *Schizostachyum* Nees and *Thyrsostachys* Gamble. **Bamboo Petung** (Figure 20), the most commonly used bamboo in bamboo construction in Bali, is issued from the *Dendrocalamus* Nees genera. This genus is characterized by being large and erect and clump-forming (or tufted), as *Gigantochloa* can be unlike other types which can be slender, smaller, single-stemmed or climbing bamboos. (Widjaja , 1995)

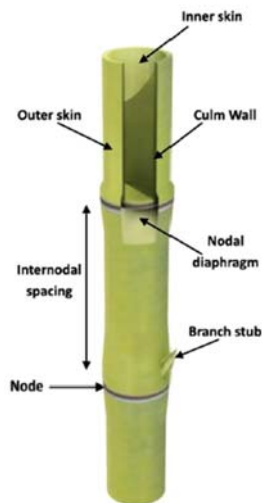


FIGURE 21 - SCHEME OF A CULM (KAMINSKI, LAWRENCE & TRUJILLO, 2016)

For raw bamboo to be used structurally in construction, whole culms tubes function as beams or columns or for the framework.

Bamboo culms (Figure 21) should be harvested during the dry season, when the starch content is at its lowest, to prevent culms from being attacked by borers, a type of moth. To use the bamboo as a building material, the bamboo should be at least 3 years old (Widjaja, 1995) but it is recommended to wait until its seventh year (Kaminski et al., 2016).

Leaves of these bamboos can also be used to make Alang-alang roof coverings. This kind of roofing is precisely the one in place in the building involved in the commented walk process that will be addressed in Section 3.3.2.

This sub-section sets the frame of the possible research fields on **tropical regions**, as the material is available in these parts of the world. More specifically in Bali, we will be interested in bamboo Petung. Moreover, the bamboo's ability to grow quickly places it as a renewable resource for construction, which bodes well for sustainability.

2.3. TREATMENTS

The **lifespan** of bamboo culms used in bamboo construction depends on the conditions of its use. Table 1 describes how many years a bamboo pole is expected to resist without alteration whether it is used in a dry interior space, external conditions without contact with the ground or in contact with the soil. It also depends on whether or not the culms have been treated and how.

Most **treatments** include sun drying the poles, drilling a hole through the nodal diaphragms, cleaning and soaking in a water bath. Later on, it can also be soaked in a salted “organic bath”, containing boric salts for instance. Eventually, it is dried and stored. As not much reliable studies were performed on the topic, this section mostly relies on the research of Kaminski et al. (2016b).

| | Untreated | Treated with Boron | Treatment with fixed preservatives |
|---------------------------------|---------------|--------------------|------------------------------------|
| Internal | 2-6 years | ≥30 years | ≥30 years |
| External above ground | 0.5 – 4 years | 2-15 years | ≥30 years |
| External in contact with ground | < 0.5 years | < 1 year | ≥15 years |

TABLE 1 - SUGGESTED APPROXIMATE LENGTH OF TIME BEFORE BAMBOO WILL NEED TO BE REPLACED (ASSUMING WARM AGGRESSIVE ENVIRONMENT WITH RISK OF TERMITE AND BEETLE ATTACK) (KAMINSKI, LAWRENCE, TRUJILLO, FELTHAM & LÓPEZ, 2016B)

As for timber construction, an appropriate design and detailing are the essential to enhance bamboo's lifespan. Several methods can ensure a lifetime lasting construction. Keeping it dry under a roof with wide overhangs can protect it against wind-blown and driving rain. Preventing places where water could be trapped and ensuring a waterproof cover layer are also different approaches. Moreover, bamboo has to be isolated from the ground with a good barrier.

Insects are the main nuisance for bamboo. Beetles attack starch in bamboo and lay their eggs inside the culm, then larvae eat the culm drilling holes with a diameter of about 1 to 6 mm. Powder beetles are the most common. Termites can also destroy bamboo, attacking both starch and cellulose. They live in large colonies so they can rapidly cause big damage.



FIGURE 22 - POWDER BEETLE ATTACK, ASALI BALI



FIGURE 23 - TERMITE DAMAGE ON A BAMBOO POLE, ASALI BALI

The treatment options depend on several factors amongst which the availability of the treatment facilities and chemicals, the country legislation, the bamboo species, transport time from harvest location to treatment facility, the budget etc. The toxicity of chemical to humans throughout its whole life, treatment, use and disposal should also be taken into account (Kaminski et al., 2016).

For temporary constructions, the treatment process only requires the bamboo culms to be cut when the starch is coming down the plant, then the poles are dried in the sun and holes are drilled through the nodal diaphragms of the bamboo along its length. It is then

cleaned in a water bath and soaked several weeks to wash out most of the starch. The bamboo should then be smoked (Kaminski et al., 2016).

Fungus attacking bamboo will cause it to rot (Figure 24). This happens when the moisture content MC is superior to 20% (Ridout, 1999; Kaminski et al., 2016). No treatment has yet been discovered to protect bamboo from rotting when in contact with water. A smart design preventing the culms to get wet is required to assure a long-lasting healthy building.



FIGURE 24 - FUNGUS AND ROT ATTACK, ASALI BALI

TRADITIONAL TREATMENT OPTIONS

Traditional simple treatment options have been commonly used for centuries in vernacular bamboo architecture. These include soaking for several weeks in water to wash out some of the starch, smoking to provide a light protective layer and painting to protect it from water. However, painting or varnishing does not adhere well to bamboo due to its smooth silica outer skin and, as the bamboo changes size under different moisture conditions, the paint will crack and allow water in (Liese, Gutiérrez & González, 2002).

These techniques thus have limited effect and should not be counted on for permanent structural bamboo. Other traditional treatment methods use naturally found chemicals or animal excrements, however these are not recommended either because their effectiveness is limited or even because some may be harmful to humans (Kaminski et al., 2016).

SEASONING

Seasoning of bamboo is a technique consisting of drying the bamboo to bring down carefully and slowly its moisture content level close to the equilibrium moisture content in service, avoiding cracks and splits by shrinking uniformly. For large bamboo, seasoning might take up to several months. Solar or heated kilns can be used to speed it up. This stage is necessary to improve bamboo's resistance to fungi and insect attack

and is essential before transporting. It limits drying shrinkage, which would otherwise affect the connections in service (Liese, 1985).

Unseasoned bamboo for construction ("green" bamboo) is cheaper and easier to work with than dry bamboo. Whilst drying, bamboo will tend to shrink and is likely to split. This will weaken it and could cause the connections to fail (Kaminski et al., 2016).

PRESERVATIVE TREATMENT OPTIONS

Preservatives treatments involve adding toxins to the bamboo to deter fungal and insect attack. Many have limited effectiveness or pose major health and safety risks. For example, older copper-based preservatives including copper-chrome-arsenic (CCA) and ammoniac-copper-arsenate (ACA) should be avoided (Kaminski et al., 2016). The two basic types of preservative that are widely used and recognized as efficient, safe, and most appropriate for bamboo are boron and modern copper-based wood preservatives. Boron is cheap to apply, effective, but soluble, so elements treated with boron cannot be exposed to water. Modern copper-based wood preservatives are way more expensive but reasonably well fixed against leaching, so can be used externally (Green Building Press, n.d.).

In most cases, especially for housing on a limited budget, boron thus remains the most appropriate chemical to treat bamboo with. Boron has fungicidal properties and is poisonous to insects. It has a low mammalian toxicity which makes it relatively safe to use for mankind. It should be noted that precautions must still be taken as, in higher concentrations, Borax acid can irritate the skin and eyes, and if ingested is moderately toxic (Kaminski et al., 2016).

Boron can usually be found as a salt and is available in most countries as a relatively cheap fertiliser, for example disodium octaborate tetrahydrate ($\text{Na}_2\text{B}_8\text{O}_{13} \cdot 4\text{H}_2\text{O}$) which is a compound used in *Timbor* or *Solubor*. For a bamboo treatment solution, it needs to be added to water. The boron solution can be reused multiple times and the residual solution can be safely diluted down and used as a fertiliser (Kaminski et al., 2016).

BATH/SOAKING

The boron solution can be diffused in bamboo by soaking it in a bath containing the mixture. Raw bamboo poles need to soak in for at least 10 to 14 days. The nodal diaphragm has to be punctured to allow the chemical to access the inside of the internodes (Figure 25). Split bamboo only need to soak in for a week. The solution can be heated to speed up the process (Liese et al., 2002).



FIGURE 25 - PUNCTURE OF NODAL DIAPHRAGMS

This process should be used on fresh culms (i.e. up to seven days after harvesting) otherwise the cell walls will start to close. Bamboo is stored upright for a minimum of one week after the bath treatment to allow the boron to diffuse throughout the culm. Bath treatment might require patience but it is the cheapest and simplest of the boron treatment methods (Kaminski et al., 2016).

VERTICAL SOAK DIFFUSION

Similar to the bath technique, bamboo culms should be fresh and holes need to be punched through but here, the last nodal diaphragm should be left unpunctured. The bamboo culms should be placed upright to pour the chemical solution directly into each culm from the top (Figure 26). The culms are left for ten to fourteen days while the solution diffuses through the bamboo, solution that should moreover be topped up periodically. The base nodes are finally punctured to drain out the chemical. Vertical soak diffusion is also cheap and is commonly applied in Indonesia (Environmental Bamboo Foundation, 2003).

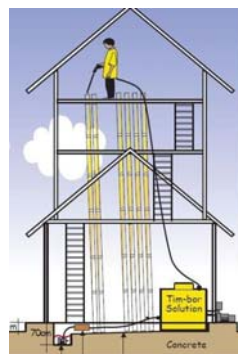


FIGURE 26 - VERTICAL SOAK DIFFUSION TREATMENT TOWER

TREATMENT USING MODERN COPPER-BASED PRESERVATIVES

New copper-based preservatives no longer contain arsenic nor chromium and are thus significantly less toxic to humans than before. Instead, they use a mixture of copper, biocides and sometimes boric acid to protect bamboo against fungi, termites and beetles. As they are chemically relatively well-fixed into the bamboo, except for boric acid components, they can be used externally and in contact with the ground. It should be noted that these treatments are corrosive to steel hence galvanised or stainless steel should be used for any metallic connexions in copper-based treated bamboo. Moreover, this kind of treated bamboo should not be burnt in the end of life as it might release hazardous chemicals.

These methods require a semi-industrial pressure treatment. The bamboo must be fully kiln-dried before treatment. After treating, the bamboo needs to be re-dried by kiln drying or natural drying. This process is rather long, expensive and difficult to implement (Kaminski et al., 2016).

MODIFIED BOUCHERIE METHOD

This method consists of a sap replacement by the chemical. The substance is pushed through the bamboo under pressure replacing its sap. This process shall take place within 12 hours after cutting the culms. If this is not possible, the bamboo must be kept moist in a tank of water until the treatment. This is the fastest method, only taking about 30 minutes per culm. The equipment needed can generally be sourced locally. Experience is necessary to ensure an effective process. The chemical can also be reused several times. It is one of the fastest and most effective treatment methods but the required freshness of the culms and the technology required are drawbacks (Kaminski et al., 2016).

To build a bamboo construction intended to last, **treatment is an essential part of the process**. Various methods exist. In Bali, soaking the bamboo in a **boric solution** is the most commonly encountered method. However, this is a recent technology which has not yet been advertised.

2.4. MECHANICAL PROPERTIES

As little reliable published studies are available, testing for strength is often required. A good approximation is that bamboo has strength properties similar to high-grade hardwood (e.g. D40). For simple structures such as bungalows or small houses, it may be possible to avoid testing and to use conservative design values (Kaminski et al., 2016).

Engineers at Asali Bali, one of the few bamboo construction companies implanted in Bali, rely for their calculations on a method based on the following norms:

- ISO 22156:2004 Bamboo – Structural design (International Organization for Standardization, 2004a)
- ISO 221557-1:2005 Bamboo – Determination of physical and mechanical properties (International Organization for Standardization, 2004b&c)
- NSR-10: Columbian code for seismically resistant construction
- NSR-G12: Structures of timber and *Guadua angustifolia* Kunth bamboo (Asociación Colombiana de Ingeniería Sísmica, 2010)
- EN:384:1995 Structural timber. Determination of characteristic values of mechanical properties and density (European Committee for Standardization, 1995)
- EN 1995-1-1:2014 Eurocode 5: Design of timber construction structures (European Committee for Standardization, 2014)

2.4.1. CHARACTERISTIC STRENGTH VALUES

Based on a moisture content of 12%, and the adjustment factors for laboratory test conditions given in table 2, the characteristic value of strength for a whole population $f_{i,k}$ can be determined from an equation based on ISO 22156 (International Organization for Standardization, 2004), and NSR G12 (Asociación Colombiana de Ingeniería Sísmica, 2010).

$$f_{i,k} = C_{\text{mois}} C_{\text{lab}} f_{i,0.05} \left[1 - \frac{2.7 s}{m \sqrt{n_t}} \right] \quad (1)$$

Where $f_{i,0.05} = m - 1.645 s$

$f_{i,0.05}$ being the fifth percentile value of strength results from test data (N/mm²),

C_{mois} the moisture content correction factor (Table 2),

C_{lab} the laboratory test condition factor (Table 3),

s the standard deviation of test data,

m the mean value of test value,

n_t the number of tests (should be >12 ; recommended ≥20).

Elements stressed in axial compression only, formed out of at least four culms connected together, $f_{i,k}$ can be determined as so:

$$f_{i,k} = C_{\text{mois}} C_{\text{lab}} f_{i,0.05} \left[m - \frac{1.645 s}{\sqrt{n_c}} \right] \left[1 - \frac{2.7 s}{m \sqrt{n_c \sqrt{n_t}}} \right] \quad (2)$$

with the same variables as before,

and n_c the number of culms connected together to form the element (Kaminski et al. 2016).

TABLE 2 - MOISTURE CONTENT CORRECTION FACTOR C_{MOIS} , AS FUNCTION OF MOISTURE CONTENT AT TIME OF TESTING.

(KAMINSKI ET AL., 2016)

| Moisture content (MC) in % | Flexure | Shear | Tension parallel to fibre | Compression parallel to fibre |
|----------------------------|-------------------------------------|-------|---------------------------|-------------------------------|
| $MC \leq 12$ | 1.0 | 1.0 | 1.0 | 1.0 |
| $12 < MC \leq 18$ | Interpolate between above and below | | | |
| $MC > 18$ | 1.2 | 1.2 | 1.2 | 1.2 |

TABLE 3 - LABORATORY TEST CONDITION FACTOR C_{LAB} (KAMINSKI ET AL., 2016)

| Flexure | Shear | Tension parallel to fibre | Compression parallel to fibre |
|---------|-------|---------------------------|-------------------------------|
| 0.7 | 0.5 | 0.5 | 0.7 |

TABLE 4 - CHARACTERISTIC STRENGTH $f_{i,k}$ FOR DESIGN OF DRY (MC 12%) MATURE BAMBOO (DEPENDS ON THE SPECIES 3-5 YEARS), FREE OF VISUAL DEFECTS (SPLITS, DECAY, ETC.) AND ASSUMING A 10 MINUTE TEST LOAD (N/MM²). (KAMINSKI ET AL., 2016)

| | Flexure $f_{m,k}$ (N/mm ²) | Shear $f_{v,k}$ (N/mm ²) | Tension parallel to fibre $f_{t,0,k}$ (N/mm ²) | Compression parallel to fibre $f_{c,0,k}$ (N/mm ²) |
|---|--|--------------------------------------|--|--|
| Columbian – grown Guadua angustifolia Kunth | 30-50 | 3-5 | 40 | 20 |
| For scheme design, all species | 30 | 2 | 40 | 20 |

Asali Bali uses the value of $f_{c,0,k} = 29,2$ MPa given a series of tests conducted by an intern in their Research & Development unit (Couret, 2018) which is a gain of 46% in strength. This value can only be used with bamboo Petung under Balinese conditions.

Table 4 gives a good approximation for $f_{c,0,k}$ for any bamboo species normalised to 12% MC. The standards require testing to determine strengths in compression, tension and shear. Moreover, it should represent as accurately as possible the variability of the material during its use. However, budget and time do not always allow previous testing. Therefore, for low-rise construction, we can use these design simplifications. Furthermore, there is no legal framework in Indonesia for bamboo construction calculations.

As previously explained in Section 2.3., bamboo should not be exposed to water nor rain. If bamboo is used outside, it shall be under cover and protected from direct rain. To prevent bamboo from rotting, poles must be treated before implementation. (Kaminski, Lawrence & Trujillo, 2016b).

2.4.2. CALCULATION OF DESIGN VALUES

The design values can be calculated with the following equation:

$$X_{i,d} = k_{\text{mod}} k_{\text{sys}} \frac{X_k}{\gamma_M} \quad (3)$$

where k_{mod} is the service class and load duration factor (Table 5),

k_{sys} the system strength factor,

X_k the characteristic strength,

γ_M the material factor of safety (Table 6).

The k_{mod} factor adjusts the strength for service class and duration. In Bali, conditions correspond to a service class of 3, relative humidity exceeding 85%. (Agency of Meteorology Climatology and Geophysics of Indonesia (BMKG), n.d.). The system strength factor k_{sys} is only used if characteristic stresses are obtained with Equation (1), it takes into account the fact that, for a continuous load distribution on at least four elements of the same stiffness connected together, it might have a gain of resistance of the whole system. Then k_{sys} is equal to 1.1.

| Service class | Permanent (self-weight) | Long-term (storage, imposed) | Medium term (imposed) | Short term (construction) | Instantaneous (wind, seismic) |
|---------------|-------------------------|------------------------------|-----------------------|---------------------------|-------------------------------|
| 3 | 0.4 | 0.45 | 0.55 | 0.6 | 0.75 |

TABLE 5 - SERVICECLASS AND LOAD DURATION FACTOR K_{MOD} (KAMINSKI ET AL., 2016)

| Flexure | Shear | Tension parallel to fibre | Compression parallel to fibre |
|---------|-------|---------------------------|-------------------------------|
| 1.5 | 1.5 | 1.5 | 1.5 |

TABLE 6 - MATERIAL FACTOR OF SAFETY γ_M (KAMINSKI ET AL., 2016)

2.4.3. BUCKLING

As bamboo is not very stiff, deflection will often govern buckling, especially flexural deflection content (Kaminski et al., 2016). Deflection checks will have to be made with the standard elastic verifications.

| Moisture content (%) | Average modulus $E_{0.5}$ (N/mm ²) | Fifth percentile modulus $E_{0.05}$ (N/mm ²) |
|----------------------|--|--|
| 12 | 10 000 – 17 000 | 7 500 – 13 000 |
| 19 | 8 500 – 15 000 | 6 700 – 8 000 |

TABLE 7 - TYPICAL MODULI OF ELASTICITY E FOR BAMBOO AT 12% AND 19% MOISTURE CONTENT (KAMINSKI, LAWRENCE, TRUJILLO, FELTHAM & LÓPEZ, 2016)

The buckling behaviour of bamboo is investigated by Chan (2012). The buckling analysis is investigated to determine at what slenderness ratio the bamboo would buckle when used as a column. The results show that a slenderness ratio above approximately 34.7 would induce global buckling to the bamboo column (Chan, 2012).

2.4.4. SERVICEABILITY LIMIT STATE (SLS)

As for the serviceability limit state, the values are based on Eurocode 5 for timber construction. It is chosen to follow those guidelines as no other studies can provide substantial recommendations for bamboo. It would be interesting to deepen research by conducting experiments to validate the assumption that Eurocode 5 is appropriate for bamboo construction.

2.4.5. FOUNDATIONS

As bamboo is not suitable to be in contact with the ground, foundations should be made of concrete and connected to the poles by steel to make sure no water might stagnate in contact with the bamboo. This is also quite similar to timber designs.

2.4.6. CONNEXIONS

Various connexion methods exist to connect pieces of bamboo together or to other materials. Connexions using rope or tenon-mortise systems, as well as steel elements or concrete filling can be mentioned. The interested reader can find additional information about connexions and traditional techniques of connexions from Hidalgo's construction manual (2018), in Appendix U.

For the verifications of connexions, the company Asali Bali relies on the Eurocode method to check bolts in wood and applies this to bamboo. A similar comment is applicable as for the validity of the use of Eurocode 5. Section 2.4.8. is also commenting the gaps existing in literature.

2.4.7. ENGINEERED BAMBOO ELEMENTS

As mentioned before, raw bamboo can also be transformed to produce other bamboo-made structural elements. The main processes, elaborated in order to get bamboo elements such as bamboo scrimber or laminated bamboo, are described in Figure 27, Figure 28 and Figure 29.



FIGURE 27 - BAMBOO SCRIMBER GENERAL MANUFACTURING PROCESS (SHARMA, GATÓO, BOCK & RAMAGE DRANSFIELD, 2015)

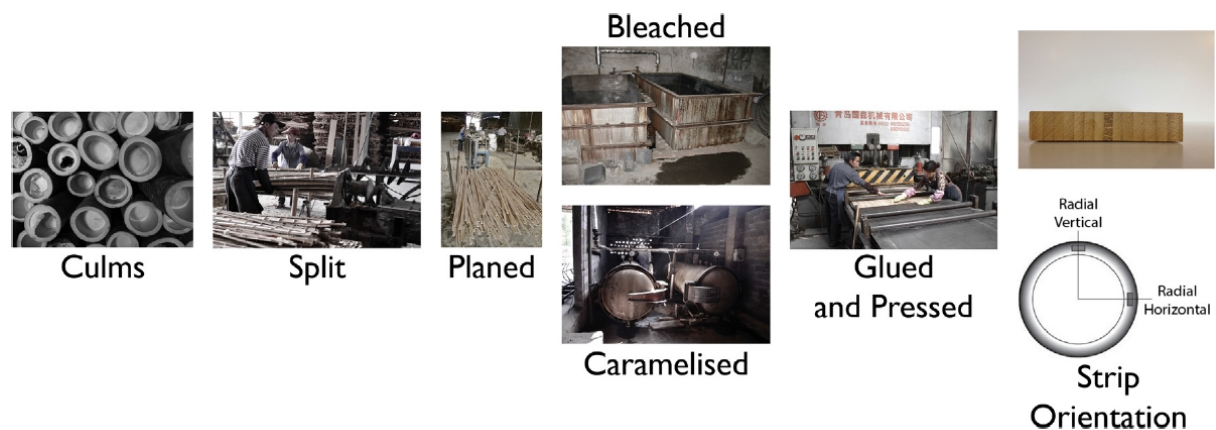


FIGURE 28 - LAMINATED BAMBOO GENERAL MANUFACTURING PROCESS (SHARMA ET AL., 2015)

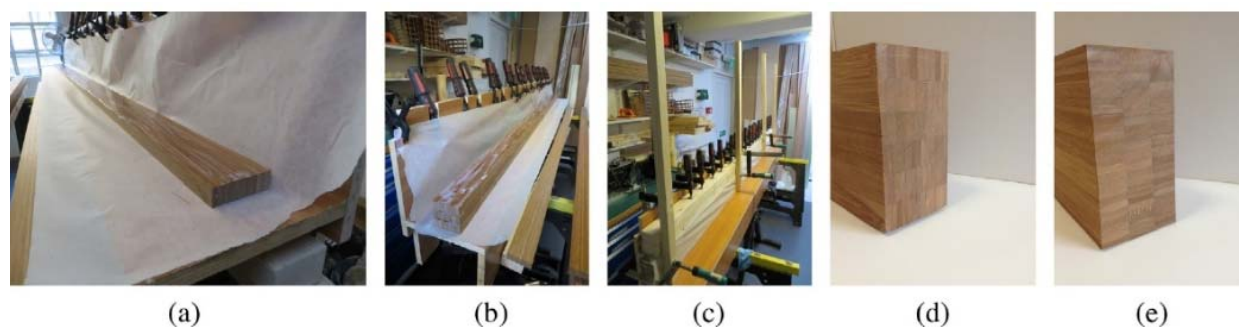


FIGURE 29 - LAMINATED BAMBOO MANUFACTURING PROCESS (SHARMA ET AL., 2015)

- (a) Single lamina,
- (b) Application of glue,
- (c) Clamped specimen,
- (d) Radial horizontal orientation,
- (e) Radial vertical orientation.

Table 8 itemises the properties of each bamboo structural elements as laid out by Sharma, Gatóo, Bock & Ramage Dransfield (2015). It also compares them to Douglas-fir Laminated Veneer Lumber (LVL).

Raw bamboo has a high density but, being hollow, still consists of light elements. In tension, Bamboo is far more resistant than Douglas LVL while other properties are quite similar. We will yet highlight the high flexural resistance of Bamboo scrimber and raw bamboo as well as the high compression resistance parallel to the fibres of bamboo scrimber.

| | Density | Compression | | Tension | | Shear | Flexural | |
|------------------|-------------------|-------------|---------------|------------|---------------|-------------|----------|-------|
| | ρ | $f_{c, }$ | $f_{c,\perp}$ | $f_{t, }$ | $f_{t,\perp}$ | $\tau_{ }$ | f_b | E_b |
| | kg/m ³ | MPa | MPa | MPa | MPa | MPa | MPa | GPa |
| Laminated bamboo | 686 | 77 | 22 | 90 | 2 | 16 | 77-83 | 11-13 |
| Bamboo scrimber | 1163 | 86 | 37 | 120 | 3 | 15 | 119 | 13 |
| Raw Bamboo | 666 | 53 | - | 153 | - | 16 | 135 | 9 |
| Douglas-fir LVL | 520 | 57 | - | 49 | - | 11 | 68 | 13 |

TABLE 8 - MATERIAL PROPERTIES FOR STRUCTURAL BAMBOO AND COMPARABLE NATURAL BAMBOO AND TIMBER PRODUCTS

2.4.8. LITERATURE GAPS IN MECHANICAL PROPERTIES

Bamboo is still not as well documented as other materials such as steel, concrete, brick or wood. Although using Eurocode 5 to approximate calculation might be of great help since there is not much published data for specific bamboo values it is still an approximation that could be tested to provide more accurate design values and coefficients. This has already been started in the Colombian NSR G12 and EN 384 (Asociación Colombiana de Ingeniería Sísmica, 2010) (European Committee for Standardization, 1995).

If strength can be widely different from the ones presented in Table 4, existing literature is not always clear about the form of strength published (e.g. characteristic, ultimate, average, design, allowable strength). Therefore, in absence of regulation depending on the location, companies can only rely on the reference of their choice, recommendations and good-practice in terms of bamboo construction.

Concerning creep, Kaminski et al. (2016) wrote: “Some people believe creep to be negligible (3-5% of elastic deformation) ; however, recent research suggests it could be as high as 50% of the initial deflection but limited research has been conducted on this topic”.

At the moment, it seems that no fire treatment has been tested for bamboo in Bali. It might not be a problem for most parts of the island as it is considered by the Agency of Meteorology Climatology and Geophysics of Indonesia (BMKG) as secure from fire, but the north and west of Bali are not that lucky as they are considered as conducive to the development of fire. Furthermore, bamboo construction could be of great interest in other parts of the world where fire might be an issue of main concern. This study will not be able to dig further into this matter, but we suggest it as an interesting area of research.

We acknowledge the current methods used in bamboo verification. Bamboo properties analysis is currently a field of interest that researchers are digging into. We have reliable data to conclude positively about the fact that treated bamboo is **technically suitable for housing**.

2.5. BALINESE CONTEXT

In this section, the Balinese context is developed. First, emblematic architecture located in Bali is displayed as an introduction to the subject. Then the geographic and demographic context is studied. The traditional Balinese architecture can now be examined. Finally, we are setting the scene of how Bali can be suggested as a place encouraging the appearance of bamboo as a construction material.

2.5.1. BAMBOO ARCHITECTURE IN BALI

In Bali, monumental bamboo buildings for tourism or foreigners coming to live in the island are multiplying.



FIGURE 30 - SHARMA SPRINGS RESIDENCE, GREEN VILLAGE, BALI, BY IBUKU

A few examples should be mentioned:

- The Fivelements project *Puri Ahimsa* by Arte architect in Denpasar (Figure 31),
- The Green School and Green Village by Ibuku, especially the Sharma Springs Residence, in Badung (Figure 30),
- The Bambu Indah Restaurant and Resort in Gianyar, also design by the Ibuku team,
- Sun Sang Eco Village designed by Chiko Wirahadi, in Tabanan,
- Beach clubs in Badung such as Finns beach club in Canggu, Karma Beach in Kuta and Azul Beach Club in Legian, all three by Penjor Bali Mandiri (PBM Architecture and Project management) (Figure 32),
- The Blue Earth Village, in Amed, Karang Asem, which design was led by Ketut Sudiana,
- The Four Seasons resorts all around Bali also hold various bamboo buildings, including a Yoga Pavilion designed by Ibuku.

The Fivelements project is mentioned as in *Archinesia 04, The Architecture of Southeast Asia, Hotel Designs*. It also won the FuturArc Green Leadership Award 2011 as the most recommended Spa Hotel in Indonesia (Akmal, 2013).

Green school and Green Village tours are organized for tourists and cost 440 000 Indonesian Rupiahs (IDR) the tour, i.e. about 30 euros.



FIGURE 31 - FIVELEMENTS PROJECT PURI AHIMSA, BALI, BY ARTE ARCHITECT

FIGURE 32 - FINNS BEACH CLUB, BALI, BY PBM ARCHITECTURE AND PROJECT MANAGEMENT

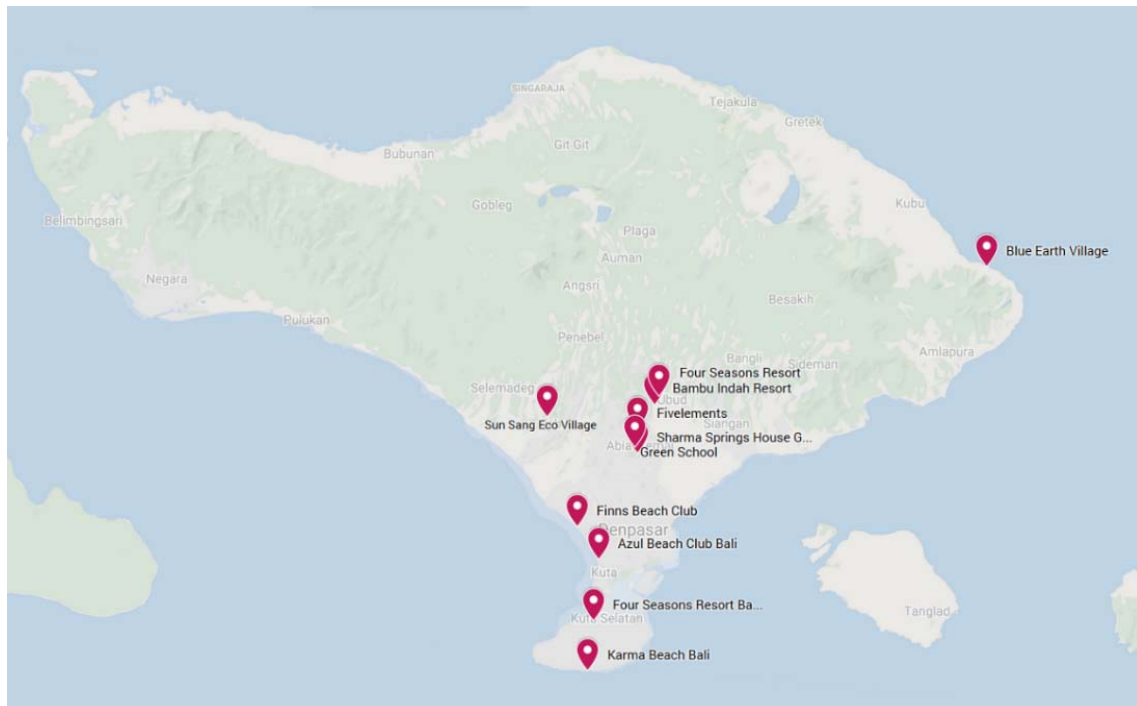


FIGURE 33 - BALI MAP, SITUATION OF EMBLEMATIC BAMBOO BUILDINGS, CREATED WITH GOOGLE MY MAPS

Examples of bamboo projects in Bali show how bamboo construction has lately been advertised as a **luxurious material** for high range touristic **large-scale buildings**. Moreover, by mapping these projects, we can see how these are mainly condensed in the districts of Badung, Denpasar and Gianyar. These are the most tourist sectors in Bali (Hitchcock, 2009).

2.5.2. GEOGRAPHIC AND DEMOGRAPHIC CONTEXT

The island of Bali is located in Indonesia, East of Java and West of Lombok and is about 5 780 km². You can expect temperatures between 20 to 33°C all year-round. From December to March, high humidity and heavy rains occur. From June to September humidity is low (World weather and climate information, n.d.). Regarding volcanic activities, there are three volcanoes in Bali: Agung (3 031 m), Batur (1 717 m) and Bratan (2 276 m). All three are active and explosive volcanoes. Agung and Batur have countless recent eruptions, some of which were deadly, sometimes destroying whole villages. While Batur has not erupted since 2000 (still 27 eruptions were recorded in the past 200 years), the Agung volcano still belches smoke, ashes and lava from time to time.

Bali is indeed located at the meeting point of tectonic plates, making it a place favourable to seismic and volcanic activities. Although Java has encountered many more earthquakes and tsunamis than Bali lately, Bali is still vulnerable to this kind of catastrophic events.

About 4.27 million people live on the island and most of the population is concentrated in the mid and South part of the land (populationdata.net, n.d.). The growth rate is of about 2% per year according to recent data. According to the census in 2010, the province population amounted to 3.89 million. However, estimations today put the population at over 4.2 million, showing that the island is experiencing a significant population growth. Because of the island's rich culture and economy which is significantly boosted by tourism, the population growth is only expected to increase in the years ahead (World Population Review, 2019). The extra population coming from this growth needs housing.

The GDP (Gross Domestic Product) of Indonesia is, according to 2017's numbers, of about 3 850 USD (United-States Dollar) per inhabitant. This is rather low compare to the European GDP per habitant, about 34 300 USD (populationdata.net, n.d.). It is clear that the emblematic buildings presented in the previous section are not benefiting the local people directly, apart from the fact that they might create job opportunities.

Some other useful data to mention, in the context of the elaboration of a survey for instance, is that 77,51% of Balinese people older than 5 years old use smartphones regularly in Bali in 2018, 67,99% of Balinese people older than 5 own a smartphone and 46,42% of Balinese people have access to the Internet (BPS Provinsi Bali, 2018).

2.5.3. BALINESE TRADITIONAL ARCHITECTURE

Architecturally, Balinese construction is very rich of traditions, layouts and ornamentations. It is mostly inspired by southern Chinese architecture and partly from southern India too (Wijaya, 2002).

A Balinese traditional house compound is typically formed of the following small buildings entities showed on Figure 34 :

- (1) Central courtyard
- (2) Family shrine or Sanggah
- (3) Principal sleeping pavilion, Meten or Bale naja
- (4) Ceremonial pavilion, Bale Bali or Bale dangin
- (5) Guest pavilion, west Pavilion, Bale dauh or Bale tiang sanga
- (6) Bale sakenam or South pavilion
- (7) Kitchen, Peacock or Paon
- (8) Rice barn, Lumbung or Jineng
- (9) Pigsty

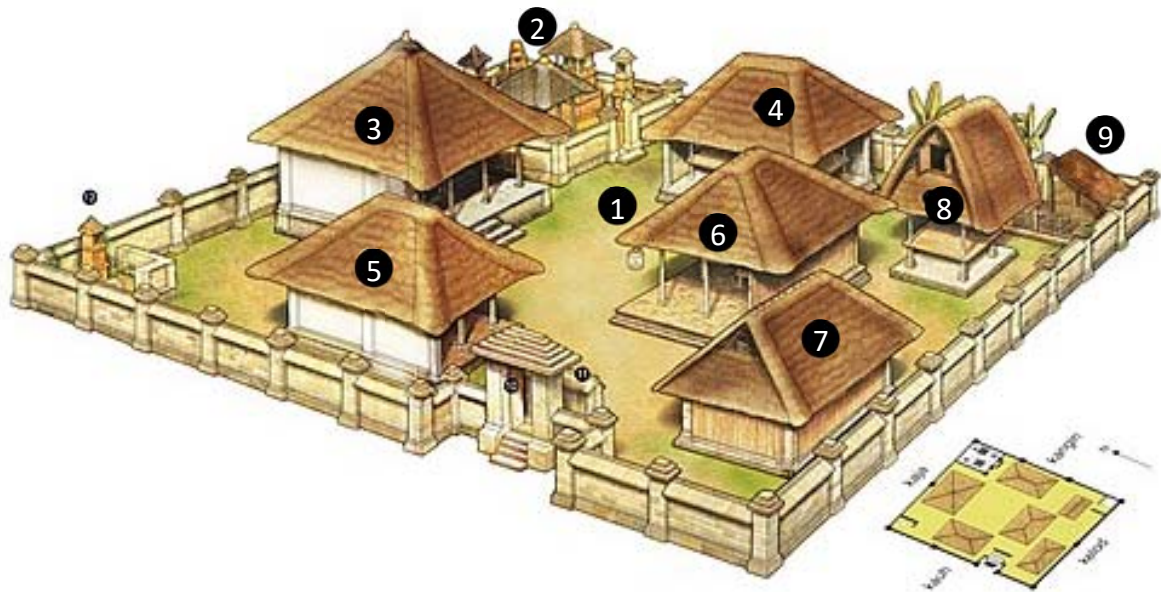


FIGURE 34 - BIRD'S EYE VIEW OF A TYPICAL RURAL DOMESTIC COMPOUND (AVIANTI, 2014)

These are traditionally surrounded by a wall called *aling-aling*, defining the land (Avianti, 2014). Currently, people tend to add to these pavilions a bathroom either inside one of the other pavilions, next to them or as an outdoor function in the enclosure.

The central courtyard is actually an outdoor living room hosting most of the family daily life. For example, dinners are often served right there.

The Bale dangin pavilion is a kind of kiosk, sitting room, siesta platform, gambling dens or love nest. It is used in miscellaneous ways during the many Balinese ceremonies throughout the year. Nowadays, it is often converted into “warung food stall” (local snacks) or new stands. It respects sacred proportions and the roof inclines in a defined angle. These recommendations are as much aesthetic and sacred matter as practical.

Bamboo is mostly used, in Balinese construction, for temporary structures such as scaffolding and ceremony sculptures. It can also commonly be found as a framework for the roof (Avianti, 2014).

Since the early 1970's, the demand for concrete structures has not stopped increasing. The standard for showing off social achievement is to have an occidental-style villa built (Avianti, 2014). In cities like in Denpasar, the density of construction needs implies the loss of these kinds of traditional distributions.

Lately, some bamboo constructions have attempted to reproduce Balinese traditional shapes. For instance, Figure 35 shows a hut inspired by the archetype of the rice barn, traditionally smaller, made of timber, and used for storage of the rice for the whole family. Here the function is different, while still all made of bamboo it serves as an office and bedroom for a private individual.



FIGURE 35 - BAMBOO HOUSE INSPIRED BY TRADITIONAL RICE BARNs, PERSONAL COLLECTION OF PHOTOS

After collecting data on the **Balinese context** to support the sequel of this study, it also appears important to take a glimpse at the architectural and traditional context in Bali. Here, we also tried to link it with a recent bamboo project, **illustrating how contemporary architecture can still adhere and fit in the traditional Balinese style.**

2.5.4. EMERGENCE CONTEXT

Bali's tropical climate and wide land is a breeding ground for bamboo to grow and thus for bamboo construction on the rise. Famous personalities such as Linda Garland and John Hardy have experimented and promoted the material in Bali, making the economy of bamboo bloom a little.

Villages, such as Belega in the district of Gianyar, specialized in all sorts of bamboo crafts (bags, cutlery, furniture etc.) are now getting a grip on construction. Bamboo could be a way of empowering local craftsmanship and entrench a local economy based on more other fields than just tourism (Picard, 2001).

The legal framework to bamboo construction is not clear in literature: there is not much information to be found and the administration seems to be out of reach for foreigners and researchers. We will see with this research what additional information we can gather on this matter.

2.6. ORIGIN OF THE RESEARCH

This section sets the scene for the study by formulating the questions of research we are focussing on. Furthermore, some of these question require a definition of the notion they use. Then we will gather clue indicators on the subject suggested by literature and background on the matter in Bali.

2.6.1. RESEARCH QUESTIONS

We have seen how bamboo construction is largely implanted in Bali nowadays, serving the field of tourism for instance. However, it does not seem to be much used as a common construction material for housing by the local population in Bali.

Can we confirm this last statement? If so, why is that?

How is bamboo **perceived** by local people in Bali? In order to answer this last question, we had to establish **qualitative indicators** as guidelines for the evaluation of the perception of bamboo housing.

This will give us a base to know if bamboo is **acceptable** as a housing material from the local people's point of view and help build a reflection on how enterprises and further researchers could manage an evolution in this acceptability state. This could also be used as a ground of reflexion for architects or administration wishing to promote bamboo construction in the tropical regions.

Here, the matter is limited to a **non-exhaustive** approach. This thesis seeks to evaluate **the perception** that Balinese people have of bamboo construction, particularly of bamboo housing. In order to do so, we have to establish **qualitative indicators** as guidelines for the evaluation of the perception of bamboo housing, responding to actual user's issues.

2.6.2. ACCEPTABILITY

If we aim to describe whether or not bamboo might be suitable for Balinese people, it is important to define what we mean by **acceptability**.

According to Raux, Souche and Vaskova, there are apparently two ways of understanding better what acceptability is: the first seeks to understand who accepts or does not accept and is therefore interested in the actors of the acceptance process, the other way asks under what conditions we accept or we do not accept this or that measure (2007). These two definitions complete each other. In our case, as we are fixing the targeted public as the Balinese population, we are looking into the actors of the acceptance process and the conditions of acceptability. Acceptability is essential to understand whether or not the object might be adopted. Dillon and Moris state, regarding the acceptance of something: "Without acceptance, discretionary users will seek alternatives, while even dedicated users will likely manifest dissatisfaction and perform in an inefficient manner, negating many, if not all, the presumed benefits" (1996, p. 5).

The choice of a material can be studied by taking into account its **acceptability *a priori***. This means focussing on the state of acceptability before the person had the opportunity to experience the object of the research. Acceptability refers to the subjective representation of the use and the relevant dimensions to be considered are perceived utility, perceived usability, expected social influences, attitudes, social norms and perceptions that will in this case play a decisive role (Terrade, Pasquier, Reerinck-Boulanger, Guingouain & Somat, 2009).

Once the individual has had the opportunity to experience a bamboo space at least once, we can properly speak of acceptance of this technology by the user. The utility and usability of the technology will, in this case, take on all their importance in predicting whether or not the technology is accepted (Terrade et al., 2009).

Investigating the possible criteria influencing acceptability, Kim states that “much work is required to identify and explore adoption factors.” (2015, p. 236). Kim’s work on acceptability of technologies highlights the factors influencing the acceptance level: age and background for instance.

2.6.3. PERCEPTION

Whether a material or technology seems acceptable to someone, as it is a subjective representation, is indeniably linked to how one perceives it. The notion of perception, however, also needs to be settled.

We defined earlier **acceptability *a priori***, focussing on the state of acceptability before the person had the opportunity to experience the object of the research. We extend that definition here to **perception *a priori*** as being the mental image one has of an object without actually experimenting it.

In contrast, we also want to define **perception *in situ* or spatial perception**. This requires a sensitive approach which should be developed regarding human and social sciences. Philosophers such as Gibson put it this way: while to sense is to passively receive information through sensory inputs, to perceive is to interpret this information (Gibson, 1976).

The spatial perception can thus be characterized by an objective part (the sound level, the luminosity, the geometric characteristics, etc.) but also by a subjective part (the sensitivity of the observer, the socio-cultural context, etc.) (Gonzalez, 2014).

The observers’ personality, but also cultural influences, related to the spatial and temporal **context** will therefore affect their perception. For Adolphe, the spatial perception, for an individual and at a given moment, is the synthesis of the multiple perceptions that the place around him suggests. According to him, each atmosphere is unique since it is the result of perceptions “of an individual at a given moment” facing the characteristics of the place (1998).

Additionnally, one has to underline that architectural space is not fully explained by the four dimensions. According to Zevi, it is moving in the building, looking at it from

successive points of view, that creates it. In other words, the fourth dimension of time gives space its whole reality (1959).

Elements that influence the spatial perception can be sorted in three groups, defined according to Thibaud (2002) as follows:

- the built forms, i.e. the physical layout of the space;
- the forms and phenomena that are sensitive to sound, light, smell, etc.;
- the social forms that engage our modes of relationship with others.

The second form specifically requires a **sensory approach**. The sight is often mentioned as the most important way to interact with architecture. It is indeed very solicited during the discovery of a place (Mertens, 2015). However, it is not self-sufficient: to illustrate this, imagine what one perceives in a photo compared to what one would perceive in reality from the same point of view (von Meiss, 2012). Pallasmaa goes even further by stating that **sight** separates us from the world while the other senses unite us with it (Pallasmaa, 2010).

The perception of **smells**, for instance, may seem secondary in architecture but it is, in fact, very important due to our olfactive memory which is relatively powerful although varying from one individual to the other (Largey & Watson, 1972). Most people describe buildings such as swimming pools, hospitals, schools, the house of their childhood or some shops with smells from back then as well as other criteria (Pallasmaa, 2010).

The sense of **touch** also is primordial, mainly through the soles of our feet or of our shoes which create a relationship with the ground (Zumthor, 2008). Beyond our feet, your whole body receives tactile information, whether it is by the materiality of a surface or by the perception of the temperature or air circulation in a room (Mertens, 2015). Apprehending an object or a surface through touch implies a movement of exploration, apprehension being part of a process (Paternault, 2013). Our skin also allows us to perceive all the textures that materials offer us. Pallasmaa states: “the skin reads texture, weight, density and temperature of materials” (2010).

Concerning the sense of **hearing**, Peter Zumthor says that “every space works like a big instrument, it gathers the sounds, amplifies them, transmits them.” (Zumthor, 2008). Walking through spaces, talking in them gives you a sense of comfort or not whether the ground cracks, the noises resonate etc.

We will distinguish one's perception of a space *a priori* and *in situ*.

The first one is the **mental image** one has of an object without actually experimenting it.

The second one consists of the synthesis they make of characteristics of light, colours, spaces, smells, noises and overall all **sensitive feelings** that constitutes the **sensory environment** (Gonzalez, 2014). All of these influence how we perceive a space and thus can thus indicate what a space conveys to someone or not.

2.6.4. FURTHER POSSIBLE INDICATORS

We already mentioned the cultural context and one's background experiences as factors that influence their perception. We also detailed the sensory indicators that can be brought up while experimenting a space.

More specifically regarding bamboo construction, the factors brought to the fore by Asali Bali during the 2017 "Konstruksi Indonesia" convention in Jakarta were the following: the **lifespan** of these types of construction, their **costs**, their structural strength and reliability -that we will simplify as the **perceived safety** of bamboo structure- and the **sustainability** of the construction. These factors are considered as a base of work throughout this study.

Another question is addressed by engineers and architects on the appropriateness of bamboo construction, which can thus be a criterion for bamboo construction acceptability: is bamboo **available locally**? (Kaminski, Lawrence & Trujillo, 2016a) This might be an important matter to deal with if we place the importance on whether or not bamboo is a greener solution for construction. If the transport of the bamboo to the location of a project requires a lot of carbon emissions, the choice of bamboo as a construction in this particular project might not be as environment-friendly as planned.

The **ground indicators** of perception we identify to base this study on are the following :

- Sociocultural context;
- Perception of the costs of bamboo construction;
- Perceived lifespan of bamboo construction;
- Perceived safety of bamboo structures;
- Perceived sustainability of bamboo houses;
- Local availability of bamboo;
- Sensory perceptions in a bamboo space.

We shall also gather additional indicators **suggested by the users and actors of bamboo construction** throughout the experiments.

CHAPTER III – METHODOLOGY

As seen in the previous chapter, we already have hints about **qualitative indicators** that could be taken into account to evaluate the perception and acceptability state of bamboo construction of local people in Bali. This chapter establishes the methods to test these indicators and investigates to add some more. We want to poll the participants in our experiment, their *a priori* and *in situ* perception of bamboo houses.

A **survey** approach through a **questionnaire** was chosen to start with, in order to reach as many people as possible. The pitfall of this method is that the data collected is somewhat raw and we do not have much idea about the background of the user filling out the survey nor in which conditions he/she will be filling it.

The second approach used to compensate for this shortcoming is the **in-depth interview**: this method is much richer in the information collected and might open up more qualitative indicators in the evaluation of user's perception of the material.

Expert actors of bamboo construction are interviewed to collect a first round of information.

An **in-depth interview** is also conducted *a priori* with a small sample of **varied profiles**, focussing on their perception and state of acceptability before they had the opportunity to be in touch with an example of this kind of construction (Terrade et al., 2009).

How one would perceive a place of some kind might also be linked to much more sensitive factors. Therefore, a third method is appropriate to try and catch as many qualitative indicators as possible. The **commented walk** puts some users in an *in situ* situation to evaluate factors of acceptance and highlight sensitive indicators of spatial perception.

The confrontation of users with an actual bamboo house might rattle the *a priori* perception they had of the object of the study by modifying their personal mental image of what a bamboo house can be, hence the in-depth **interview a posteriori** will complete this research procedure.

The following sections will shortly review the **state-of-the-art** of each method, the **experimental protocol** constructed and the way the **data** is **processed**.

| METHOD USED | Sample | Broad sample | Small sample Ayu, Ade, Devi, Ngurah | Sample of experts Chiko, Thierry, Putra |
|-----------------------|--------|--------------|--|--|
| QUESTIONNAIRE | | 57 | / | / |
| IN-DEPTH INTERVIEW(S) | | / | 4 | 3 |
| COMMENTED WALK | | / | 4 | / |

TABLE 9 - EACH METHOD'S NUMBER OF PARTICIPANTS

3.1. SURVEY

3.1.1. STATE-OF-THE-ART

To conduct field research, an inventory of available resources should be outlined such as budget, workforce, time and materials. In this case, we shall focus on the **questionnaire** approach as time and workforce were extremely limited and the survey was a prompt and efficient way to get an idea of criteria emerging from a sample of lay people. Answers collected might be a little raw and not much detailed but the number of answers is wider than for the in-depth interviews (Ratier, n.d.).

The survey conducted is in the form of directly administered questionnaires. This means that the interviewees write down answers themselves on the questionnaire.

The purpose of the inquiry has to be clearly defined. In this case, it is to highlight what could be indicators of qualitative bamboo housing. The questions have to be clear, neutral and adequate regarding both the subject but also the population aimed at (Ratier, n.d.).

The population consists of people living in areas where bamboo can be locally found in abundance, thus tropical regions. As mentioned before, to limit this vast subject to an accessible one given the time-span of a master thesis, the region will be limited to Indonesia, especially the island of Bali. Among the population in Bali, there are people from other islands of Indonesia or other parts of the world. Taking into account the opinions of people living in Bali but coming from other tropical regions might be of great interest, but we are trying to keep this **research framed**.

The size of the sample will matter to figure out its representativeness according to the Balinese population. The accuracy of the results obtained increases with the number of people questioned (Javeau, 1982).

A pre-testing phase should be conducted at first. The purpose is to assess the ease of understanding, the degree of acceptance and the ease of interpretation. During this test, the questionnaire must be submitted to a limited number of people. The group must not be too homogeneous. During the pre-test, the terms used need to be checked to be easily understandable and unambiguous. If there is any difficulty of comprehension from participants, formulations should be corrected. The order of the questions must not give rise to any possible distortion of reaction. This test should also determine if the questionnaire is not too long and does not cause disinterest or annoyance of the interviewees. (Ratier, n.d.). Typically, it should not last more than 10 minutes.

The **procedure** for the elaboration of the questionnaire is sequenced as follows: write the draft questionnaire, put the questionnaire in shape, test the draft questionnaire, carry out the definitive questionnaire, carry out the investigation. Processing of the data collected through the questionnaire and validating the sample will finally take place when no more questionnaires are being filled (Ratier, n.d.).

3.1.2. EXPERIMENTAL PROTOCOL

The survey questions are divided in four sections. Firstly, the aim is to get to know what kind of profile the participant has: age, where they come from, occupation etc. Secondly, we aim at getting an idea on the type of construction materials they are familiar with. Only then the survey starts focussing specifically on bamboo construction: participants are invited to write in open questions what bamboo construction conveys for them, if they would be interested to build in bamboo and what they would use it for, if at all. In the last section, some more open questions aim at getting data about pros and cons of bamboo construction in their opinion, then ranking the cost of bamboo construction comparing it with other materials they might know, asking them how long they think a bamboo houses could last. It also addresses questions on regulations they might know about according to construction in their district and if they know people living in bamboo houses and what they would think about that. The full survey form is available in Appendix A and B.

The test draft, in the case of this particular study, was only taken by four people. This is due to the means and time schedules for a four-month-long master thesis with limited stay abroad.

As for the final sample, it eventually counts 54 individuals. This rather limited amount of respondents is the consequence of several issues encountered on the field.

Spreading the survey was a complex task. Methods used were diverse. Firstly, the survey was posted online in English and sent to a couple of people we knew from different locations and various profiles (all from Bali, a 60-year-old teacher, a 40-year-old driver and a 20-year-old butler). They were each asked to share the link with at least 3 other people. Then, the link was posted on social medias asking contacts to share with people living in tropical regions. Posters were moreover displayed in supermarkets and streets in Bali with a QR code sending people to the online survey form.

This method did not work very well as only 5 surveys were completed after about 2 weeks. The problem was mainly due to the fact that people either did not understand the English survey properly and thus could not complete it, or that they did not feel concerned to scan a QR code for a random survey they did not even really understand what it was for. It could also be that not many people had access to a connected smartphone, but observations on site pointed otherwise.

The next step was then to find someone bilingual to translate the survey from English to Bahasa Indonesia in order to make it more accessible. The translation was completed by 3 people, a French man living in Bali and two native Balinese women. This way, the translation was triply checked to make sense in Indonesian while keeping the meaning it had originally. The survey was then published online and the posters were changed to a QR code leading to the Indonesian version.

Unfortunately, these additional efforts did not bring much more information, only a couple of new answers were added to the form.

Finally, as only 46.4% of Balinese people have access to the Internet (BPS Provinsi Bali, 2018), the last diffusion method was to print surveys and give them out in various public places: bars, restaurants, on the train, in administration centres etc. Almost fifty forms were distributed during a period of forty days.

3.1.3. DATA PROCESSING

Once the survey period is over, the first step consists of transcribe all of the paper questionnaires on the tool *Google form* along with the previously recorded online surveys. Once this stage is over, it is interesting to check if the diversity of the sample can be considered representative of the Balinese population. Thus, the ages of the participants are compared to the Balinese pyramid of ages. The population distribution in Bali is also compared to the districts registered for the participants.

Then the data can start being used and operated to highlight the characteristics of the participants, the keywords common to some of them, the perception they might have regarding bamboo construction or, on the contrary, how the perception might vary from one another and try to observe if any correlation can be hypothesized between, for instance, age, provenance or occupation field of participants and a certain type of opinions.

3.2. IN-DEPTH INTERVIEW

3.2.1. STATE-OF-THE-ART

The in-depth interview is a qualitative method for collecting data that is widely used in the field of scientific research. We can distinguish three types of interviews: guided interview, semi-structured interview and non-directive interview. Each type of interview has its own characteristics in the way it is planned and conducted. The researcher can establish an interview manual to guide the interviewer throughout the process. This manual allows the interviewer to list the topics he/she is interested in and will discuss with the interviewee.

The guided interview uses a proper manual constructed as a questionnaire. The interviewer then pays particular attention to the relevance and order of the questions. This method can be particularly laborious and does not let much flexibility to interact and dig into each individual's experience.

Non-directive interview does not require a manual. The interview takes place more spontaneously, for example according to the live interpretations made by the researcher. This type of interview is particularly used in the context of research in psychology and sociology, disciplines where the studied phenomena are complex and less known, and where some simulations make it difficult to apply a directive method

(Gonzalez, 2014). In order to replicate more or less the same interview with several interviewees, a handbook might still be of use.

Thus the semi-structured interview is the one selected for this research. Like the guided interview, it is prepared with the help of a handbook. However, the guide is here a help to the researcher, and no longer a list of questions to ask the interviewee. It is more of a reminder to guide the researcher and help him/her to go through the major topics without losing too much focus whilst still being flexible and able to dig into deeper information. This type of interview then is more natural for the interviewee who seems to be more open to a discussion. However, from the researcher's point of view, rigorous and demanding work is required in the conduct of the interview.

The conduct of this interview allows the interviewee to express himself/herself "freely" on topics he can address spontaneously (Gonzalez, 2014). Since the researcher still has a guide to direct the discussion to main topics, he can relaunch the conversation with some more questions if the interviewee falls short of comments.

In this case, interviewing a sample of the population of Bali on bamboo construction is a way of getting qualitative detailed answers on whether bamboo construction might be acceptable for participants and establish possible criteria the architect might want to look into whilst designing a bamboo house.

This type of interview should not be seen as a way to quantify the collected data. It is more of a "field investigation" allowing this research, together with the data collected with the surveys, to sketch a list of possible indicators for qualitative bamboo housing. The purpose here is also to try and have the interviewee telling anecdotes. Beaud insists that the anecdote is a true lever for ethnographic interview where decisive elements for the research might appear. In order for this to happen, the researcher needs to build a bond of trust with the interviewee and external conditions should help make them comfortable (1996).

Furthermore, to stimulate their imagination, try and get them to talk and describe how they perceive bamboo construction and qualitative factors they would use to characterize it, we introduce a technique called photo elicitation, which can be conducted half-way through the in-depth interview or later (in order to have already canvassed the *a priori* perception of the material). This technique is described in Pretto's work (2015) and basically consists of placing an image between the researcher and the interviewee as a support for conversation. The picture can either be chosen in advance by the interviewee and brought to the meeting or can be brought along by the researcher. In the latter case, bamboo construction images, the same ones for all interviewees, are brought by the person interviewing. A bunch of pictures are available and the interviewee is asked to choose at least three of them to discuss. It is also suggested to bring along pictures of their own house as support for the discussion but

this is only used to try and make them more comfortable while talking about other materials they know and can show in the pictures (see Appendix C.3.).

Regarding the matter of representativeness of a sample of individuals in in-depth interviews, Savoie-Zajc (2007) tells us that the construction of a scientifically valid sampling in qualitative and interpretative research is based on general characteristics: the sample must be purposive, relevant to the object and to the questions of the research.

As this is an **ethnological approach**, the stake of the interview methods is not about establishing new typologies of interviews, but more about appreciating the relative value of adjustment of this investigation instrument. It is necessary to be able to evaluate, step by step, during the interview, the validity of the survey techniques available to the interviewer. In other words, the in-depth interview benefits from being used in an ethnographic survey being therefore **flexible** and adaptable to the researcher's purpose (Beaud, 1996).

3.2.2. EXPERIMENTAL PROTOCOL

As experts in the field might have a different experience with the material which influences and forges their opinions on the matter (Thibaud, 1998), their *a priori* perception of bamboo housing might still be interesting to get detailed indicators but might not be very representative of most Balinese people. Thus the experts will be interviewed with a little more attention to their specificities whereas another group of various-profile-people will be chosen for a more complex process, which will be described in the following sections.

Every procedure is preceded by the presentation of the experiment as being a part of a master thesis and a brief on how it is going to go. Then the researcher presents the interviewee a consent form for them to sign, stating they agree to participate and asking them if they would like their identity to be mentioned or not.

IN-DEPTH INTERVIEW OF A GROUP OF EXPERTS

This group was interviewed in order to have detailed information from experts. By experts, we mean people who have a relatively long experience with bamboo construction. Still this experience can be of various natures. In this case, opportunities brought up by the context of staying on site, in Bali, for two whole months allowed the research to include three experts in-depth interviews: one of a bamboo construction engineer, the second one of an architect specialized in bamboo houses and the last one with the owner of a bamboo house.

These in-depth semi-structured interviews were relying on a checklist of subjects that could be discussed, customized depending on the profile of the interviewee. These handbooks are transcript in Appendix C.1., "In-depth interviews of experts".

The interviews either took place at the participants' home, for the owner of a bamboo house, or at their working place for the architect and the engineer. The architect's working place happened to be a part of his home as well. These locations were chosen by the interviewee for convenience and were later validated by the researcher as it was relevant to be in an environment bamboo-related as well as somewhere they could feel comfortable discussing.

IN-DEPTH INTERVIEW A PRIORI

For these in-depth semi-structured interviews, the purpose was to mix various profiles and repeat the same procedure in order to evaluate the perception they might have *a priori* of bamboo housing and collect some indicators used to describe and judge the mental representation they have. As well as to try and compare these indicators and identify if some are recurring.

The participants were solicited either on social media, directly in person when meeting them, or on the phone. Again, posters were placed in several towns but no candidate got in contact to take part to the research. On social media, several Balinese young people found on Instagram were asked and two of them answered positively. By phone, going through phone numbers of Balinese hosting foreigners at their lodge, one of them agreed to participate in the study. Finally, when meeting people and shortly bonding and feeling they felt relatively comfortable with English, the researcher asked Balinese people if they would like to participate in a research on construction materials for housing. One last person agreed, an accountant working at Asali Bali thus remotely in contact with bamboo construction but not quite an expert in the field.

All the interviews took place in Abiansema, Badung, in a café. There was no bamboo around in the café that could orient the mental perception of bamboo for the interviewees. The place was calm and seats comfortable. The researcher made sure the interviewees had eaten and could have drinks throughout the interview.

The process of the interview was based on the handbook drawn up for this purpose (available in Appendix C.2.: in-depth interviews *a priori*). The implementation varied a little from a participant to another, as the in-depth semi-conducted interview must stay flexible and adapt along the process to the ways the discussion might be taking, to allow the interviewee to express richer life experiences and deeper opinions.

As mentioned before, this would be the interview based on prejudice and mental images the participant has of bamboo construction and houses. No constructed form (Di Méo, 1990) is given to the interviewee in the first stage of the process. The image is only present in the conscience of the participant and, therefore, is not accessible to the researcher. Comments collected are only based on a preconceived idea of what the bamboo house is, which depends on a multitude of factors among which culture, experience and state of mind may play a role. This perception *a priori* is what we will firstly be interested in.

Then we will also **target perception** via the sense of **sight** alone, through **the photo elicitation**. The other senses will be looked in throughout the commented walks.

For the photo elicitation, the chosen images are available in **Appendix C.3**. These pictures were selected because they illustrate small-scale bamboo buildings that could be houses and living spaces featuring bamboo as an apparent structural material. Some of these projects are actually located in Bali. I have had the chance of visiting them.

IN-DEPTH INTERVIEW A POSTERIORI

The entire sample participating to the in-depth interview *a priori* agreed to participate in the commented walk as well. Thus, to evaluate if this part of the experiment had an impact on their perception of bamboo housing and give them a last chance to express their opinions, feelings and experiences, the procedure involves an in-depth interview quite similar to the first one but following the commented walk.

The retrospective verbalization techniques all call upon the memory of the subjects to collect their comments on the event. This step can therefore be carried out from a few seconds after the completion of the action until several days later (Forget, 2013). What differentiates the two main variants of this technique, which are retrospective verbalization and assisted retrospective verbalization, is the absence or presence of material support "sometimes necessary to help the subject to better remember the sequence of his/her actions. It can be a list of cognitive processes potentially set up during the activity, the product of the task performed previously (text, model, exercise) or the audio or video recording of the event in which the task has been completed" (Forget, 2013). In the present case, constraints due to the participants' and researcher's agendas implied having to make the *a posteriori* interviews right away, just after the commented walks, on the spot, with no visual nor hearing support, but just talking about how they felt throughout the visit, and comments are thus based on a constructed form accessible to the researcher's knowledge.

3.2.3. DATA PROCESSING

The analysis of these interviews has two main objectives: to discover how users consider the bamboo-made habitats, in which aspects, and to collect the criteria/indicators on which they base their opinion to qualify the space. The consideration expressed, whether positive or negative, comes only in second place of interest but nevertheless allows briefly assessing the state of acceptance the interviewee is at, considering the material.

For all of the in-depth interviews, the first stage of the process is the same. It consists in a transcription as accurate as possible of the audio recording. Thus the unsaid, laughs and hanging words also matter if we are having a proper sociological approach (Beaud, 1996).

IN-DEPTH INTERVIEW OF A GROUP OF EXPERTS

Some very interesting points of the discussions will be highlighted and used to formulate specific indicators we should not neglect. This will either take the form of direct quotations from the discussion or general ideas that can summarize some of the main thoughts expressed throughout the interviews.

IN-DEPTH INTERVIEW A PRIORI

Here, the stake is to go through the interviews and highlight any comment that can describe qualitative indicators influencing the perception the user interviewed has of what a bamboo house is like, whether or not it might be a suitable structural material for a house to live in and why.

A “profile” description synthesizing each user’s profile is addressed, emphasizing the perception each participant has on the matter. Finally, the comments of the same nature are grouped together, crossed between the various users and compared.

IN-DEPTH INTERVIEW A POSTERIORI

Again, the process is very similar to the data processing of the interview *a priori*, whereas the stake is going to be in comparing both the perception before and after the commented walk whilst still maybe adding some information to the description of the profiles of interviewees.

3.3. COMMENTED WALK**3.3.1. STATE-OF-THE-ART**

The awareness of the sensitive approach needed to express some special experience in architecture leads to the commented walk method. According to Zevi, it is moving in the building, looking at it from successive points of view, that creates it. In other words, the fourth dimension of time gives space its whole reality (1959).

Pallasmaa (2010) goes even further in this phenomenological approach saying that to understand the scale of architecture involves unconsciously measuring the object, the building with one's own body and senses. Thus perception of a type of spaces can only be fully described by actually being in an example of these.

A space can be defined by criteria that are intrinsic to the place and therefore quantifiable. However, spatial perception apprehends it through the eyes of an observer which makes it subjective, non-separable from the action to experience (Gonzalez, 2014).

The method of the commented walks should be considered as an open method providing material for many variations. If the methodological hypotheses that it sets out establish the general framework, the survey protocol and data analysis can be modulated by the researcher to fit his needs (Thibaud, 2001).

This method involves asking several people to walk around the site and describe out loud everything they perceive. The cross-analysis of transcriptions identifies then makes it possible to highlight communities of perception for this site. These results, correlated with the researcher's knowledge of the premises, then make it possible to pass from the ordinary user experience to the site's sensitive configurations (Thibaud, 1998). The purpose of this experiment, let us not forget it, is to evaluate the acceptability of this type of dwelling by drafting several indicators of sensory perceptions in an archetypal construction of a domestic bamboo building.

Thibaud's method seeks to study social practices in public space and their relations with the sensitive environment in which they take place. In the case of this particular study, however, the method is applied to the private domain of a domestic house. Moreover, in his protocol, Thibaud privileges users-observers people who might already be familiar with the site. As part of the study of the acceptability of a material, we suggest to put the participants in an unseen place and compare several experiences in vis-à-vis.

What may occur, throughout the tour, is that the state of acceptability of the material as building material for housing gets modified. This is why, for the entire sample subjected to these commented walks, a post-interview is planned. Although the modification of the perception is not a goal in itself, it is interesting to collect the *a posteriori* opinion to compare the data with the opinions stated during the *a priori* interview and evaluate whether or not acceptability has evolved and what factors might have influenced this change. If so, the question of whether it has moved in favour of the material or not is relevant, too.

Furthermore, in order to understand better the driving phenomena of the environments actually perceived, it is interesting to compare the results of *in situ* experiments with an analysis of the space designed. This would allow to quantify the characteristics of the studied bamboo spaces. However, a complete scientific analysis of these spaces would include measurements of brightness, soundscapes, etc. and such a study would require further means and a larger research framework.

We are only interested, throughout this method, in the **sensory approach**, that is to say the perceptions expressed by the users. We try to **validate** or **rebut the indicators** highlighted before as well as **collect potential new ones**.

3.3.2. EXPERIMENTAL PROTOCOL

Firstly, the researcher determine where the commented walk shall take place and visit it in order to understand its functioning. In this case, the stake is to find a house that can exemplify a typical Balinese middle class treated bamboo house. We contact the few bamboo house owners we can find by word of mouth: some of the houses were too luxurious, some owners would not agree with lending their homes for an experiment. Finally, we find someone willing to host us. He signs a consent form but asks for his name not to be mentioned in this study.

The owner owns two bamboo buildings and agrees for us to visit both. One is his home. It is hidden from the road by vegetation. The other one, located further on his land, is a small storage extension and is accessible by a small path without passing in front of the house.

The participants are asked to meet the researcher nearby in a small street close to the house but not directly in front of it. The researcher explains again the context in which the study is driven and the fact that the meeting is going to be taped and recorded.

Then the researcher takes the participants to a first building, the storage extension. It is about 9 square metres (Figure 36). This building layout and proportions are very much alike Meten pavilions (cf. Section 2.5.3. Balinese traditional architecture). It is thus an archetype of how bamboo construction can fit within the traditional ways of building.

The second building is the owner's home, an eighty-square-metre house, one bedroom, with an outside bathroom and a mezzanine floor in the living room for storage and guests to sleep (Figure 37 and Figure 38).

The following layouts are schematic, just to get an idea of the arrangements. They were drawn after a quick sketch on site as the owner did not have proper layouts to share.

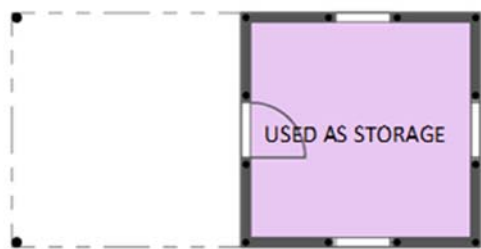


FIGURE 36 - SCHEME OF THE 9M² STORAGE PAVILION VISITED DURING THE COMMENTED WALKS

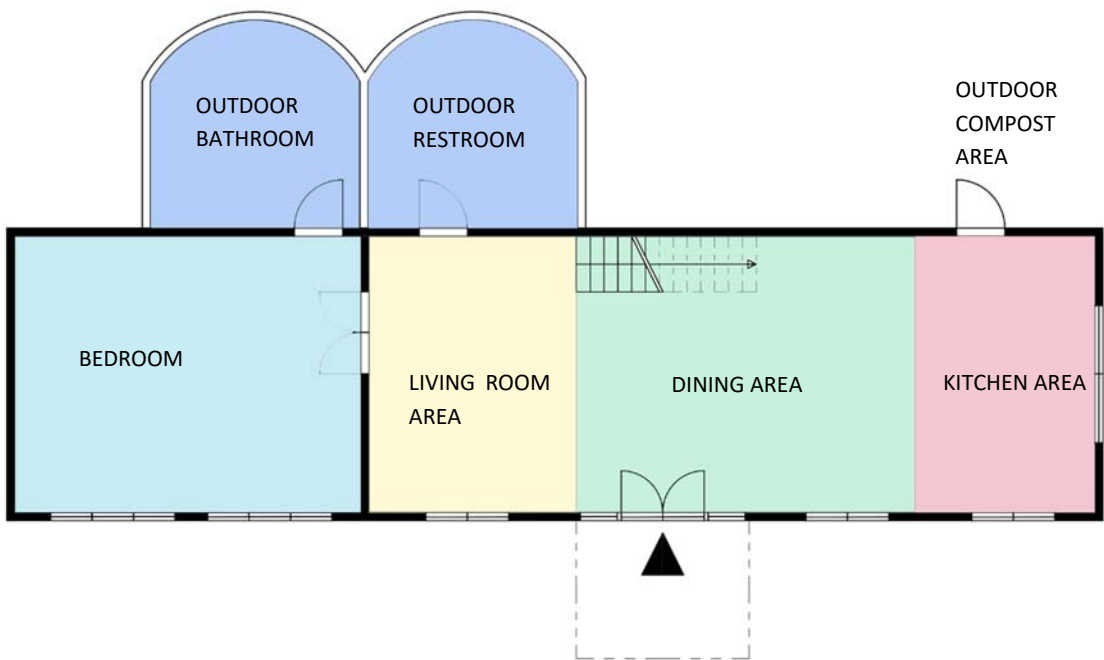


FIGURE 37 - GROUND FLOOR OF THE HOUSE VISITED DURING THE COMMENTED WALKS

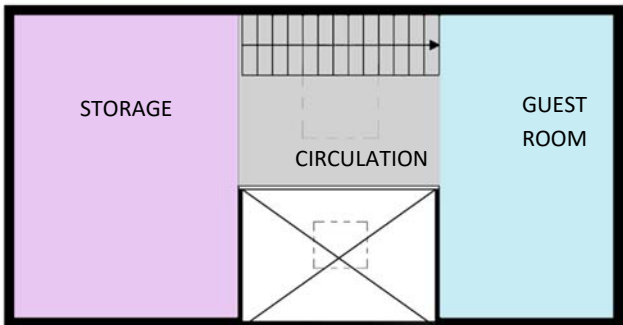


FIGURE 38 - MEZZANINE FLOOR OF THE HOUSE VISITED DURING THE COMMENTED WALKS

The handbook here is more of an aide-memoire for the visit:

- 1- Define the instructions relating to the description and the duration of the experiment,
- 2- Re-explain the context of the study (master thesis),
- 3- Launch the cameras and the Dictaphone,
- 4- Present a scenario to the potential user: they are told to imagine that these buildings are their own. The first one is presented as an extension to their current house. What function would they like it to be for?
The second visited building is a whole new home for them.
They get to discover the spaces and are asked to explicitly comment the feelings, sensations, thoughts and opinions about it. Does it correspond to their expectations for a new building of their own?
- 5- Insist on their sensory perceptions: What do they think of the place? How do they feel? What does it smell maybe? They are asked to give a sensory feedback (visual, olfactory, sound, touched).
- 6- Return to the site if possible to identify in detail the conditions from which appear phenomena described by passers-by, reversing the relationship between observation and description: it is no longer a question of describing what one perceives but of relating the descriptions to what is observable on the spot (Thibaud, 2001).

In this case, the last point is not possible to organize as the agendas of researcher, participants and owner are not fit for it. However, the fact that the researcher might film the visits may give them the opportunity to come back to it if necessary.

As already mentioned and described in Section 3.2., this experiment is followed by the *a posteriori* in-depth interview.

3.3.3. DATA PROCESSING

Like in-depth interviews, the analysis of this study has two main purposes: to discover how users approach the bamboo habitat, in which aspects and to collect the criteria on which they base themselves to qualify the space. The difference lies in the fact that space is no longer only addressed in a pure ideological representation, but here is concretized by a real physical example of bamboo house. The part of preconception mentioned in the interview *a priori*, now gives the way to concrete comments, on the spot. The object of those comments relates to a constructed space known to the researcher and whose characteristics could have been measured.

Just as for the in-depth interviews, the first stage of data processing is to transcribe the comments and discussion after the walk based on the audio recordings. These transcripts are available in Appendix C.4., by courtesy of the users who have participated in this *in situ* experiment.

Then, the stake is to highlight any comments regarding the perception of the material that can inform qualitative indicators influencing the perception of the user of the space. For each user, we note the words that seem to be relevant to determine what is perceived or experienced by the user and how. Indeed, according to Thibaud (2001), the descriptions collected are oriented by the personal judgments and the appreciations, positive or negative, that the user has of the place. To do this, we note the qualifiers, the names describing their spatial perceptions and the meanings that these have made emerge. We also note the recurrence of these words. Thus, we can later interpret feelings, judgments or themes used frequently during the process.

Finally, the comments of same nature are gathered, crossed between the various users and compared. Once again, it is the redundancy of comments of the same nature, coming from different observers, which attests to a certain "community of perception" (Gonzalez, 2014).

In the end, we obtain a list of criteria used by users to characterize the spaces. This list is not exhaustive, is directly related to the perceptions that have been made in regard of the specific site and of the limited number of users involved. These sensitive criteria can be the baseline for qualitative indicators for bamboo housing, broadening the criteria collected by other means, in this case the survey and in-depth interviews.

CHAPTER IV – RESULTS

This chapter presents the results of the experiments conducted: first the survey, then the in-depth interviews *a priori* of the varied profiles, followed by the commented walks, and a posteriori in-depth interviews, then the in-depth interviews of the group of experts. We will add to this last section (i.e. section 4.5.) some passages of a conference speech that was given by Elora Hardy, lead architect of the Ibuku team, in April 2019, in Seminyak, Bali. She addressed various topics of interest for this work and agreed for us to use the transcript of this conference in the present study.

4.1. SURVEY

In this section, the results of the questionnaire survey are presented. We note that 57 surveys have been filled in. Amongst them, 54 were taken by Indonesian people. The three other participants come from Europe, the Reunion Island and Cameroun, thus they fall outside the scope of this study. Their answers are therefore not be considered in the rest of this study.

First, we check briefly the representativeness of the sample studied. We then look into the common construction reference materials of the participants. Furthermore, we investigate the perception *a priori* they have of the material and search for factors influencing it. Finally, we highlight the key topics regarding bamboo construction throughout the answers given.

4.1.1. REPRESENTATIVENESS OF THE SAMPLE STUDIED

Firstly, to evaluate the representativeness of the sample we contracted through the survey (online or paper form), we will have a look at the age of the participants as well as the districts they come from.

Out of 57 surveys filled in, 54 were taken by Indonesian people. Amongst the Balinese people answering the survey, Figure 39 presents in proportion their originating districts.

The Figure 40 represents the different districts as registered by the administrative divisions in Bali. The colours express the density of population in each district.

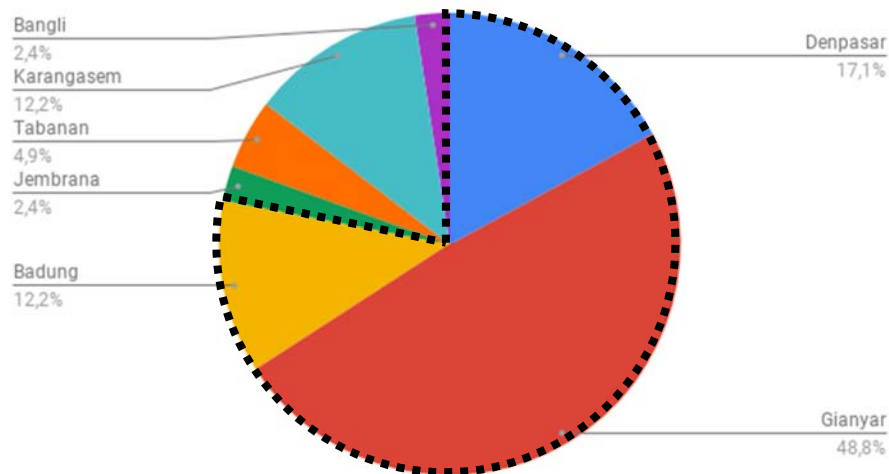


FIGURE 39 - DISTRICTS OF BALINESE PARTICIPANTS

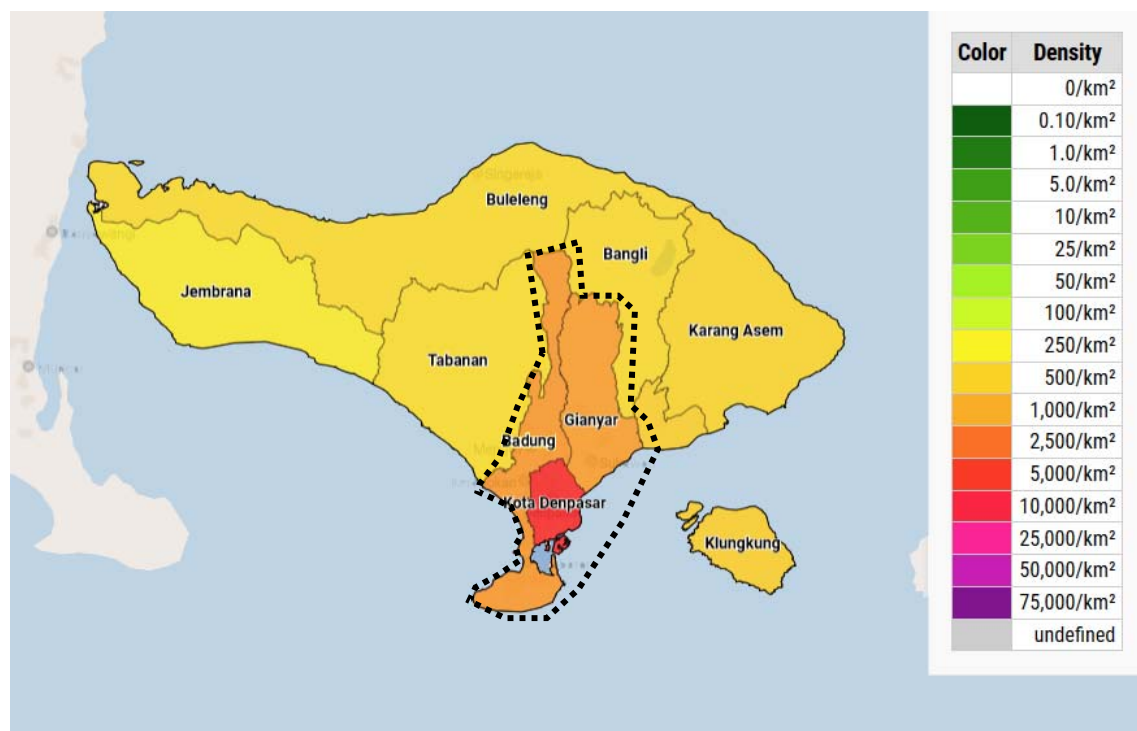


FIGURE 40 - BALI, PROVINCE IN INDONESIA, DENSITY, CITY POPULATION.INFO

As we can see, the density of population is higher in Badung, Gianyar and especially in Denpasar. Other districts are less dense. Amongst the participants filling in the questionnaire, Gianyar is overrepresented. Nevertheless, 78,1% of the survey participants come from the three denser districts, Gianyar (48,8%), Badung (12,2%) and Denpasar (17,1%), which altogether represent the most important part of the Balinese population.

Another factor that can be used to check if the sample representativeness is the range of ages. The Figure 41 shows the pyramid of ages published by the Indonesian Central Body of Statistics in the Statistical Health Statistics report of the province of Bali in 2018.

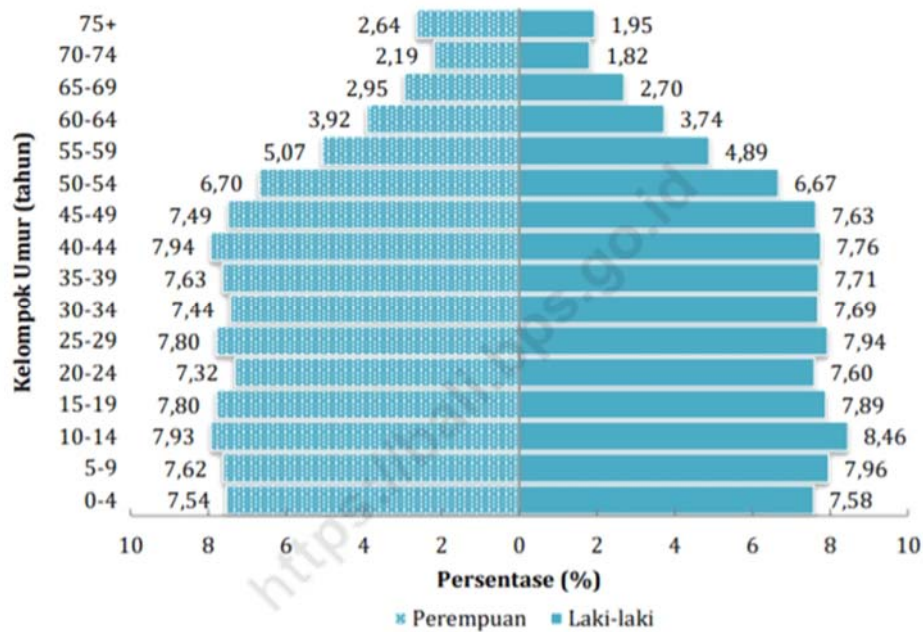


FIGURE 41 - AGE PYRAMID, POPULATION IN 2018 IN BALI, BY THE INDONESIAN CENTRAL BODY OF STATISTICS.

ABSCISSA: WOMEN ON THE LEFT, MEN ON THE RIGHT

ORDINATE: RANGE OF AGE

Below is the repartition of our participants' ages:

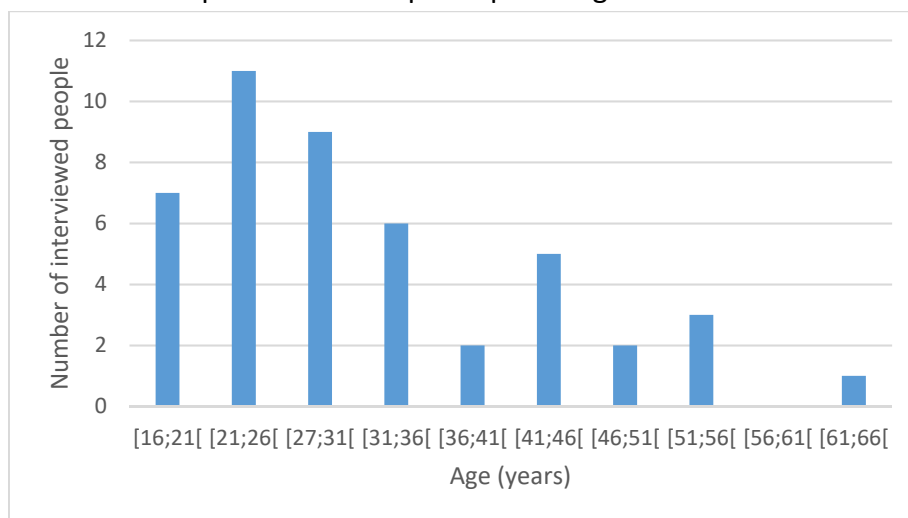


FIGURE 42 - RANGE OF AGES OF THE PARTICIPANTS IN THE QUESTIONNAIRE

We notice that both diagrams look very similar. We put aside children under 16 as they are too young to answer this questionnaire. 16 to 40 year-olds are more represented than the rest. However, the global range of ages still goes until the 60 year-olds people, thus corresponding approximately to the range observed in Figure 41.

Of course, both of these “verifications” are not sufficient to guarantee the sample representativeness, given its very small scale. Nevertheless, these kinds of verifications are still interesting to check and can, on a larger scale, attest to be the relevance of the studied sample. Here, we will indeed not talk of actual representativeness but rather of **relevance** of the sample.

4.1.2. COMMON CONSTRUCTION MATERIALS

Among the first questions participants had to answer, the following questions are about the materials their houses are made of, their neighbours' houses are made of and about the ideal material they would choose to build a new construction (Figure 43). These questions aim to discern the standards in materials for the people questioned.

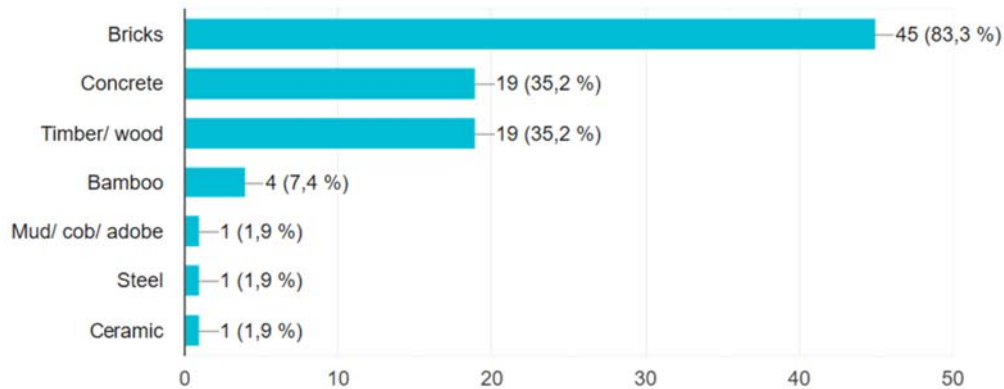


FIGURE 43 - PERCENTAGE OF PEOPLE SELECTING MATERIALS COMPOSING THEIR HOME

Thus the reference materials seem to be bricks, concrete and wood. A few people still have bamboo in their homes but usually not as the main construction material, as it is always selected along with another one of the three main materials (brick, concrete or wood).

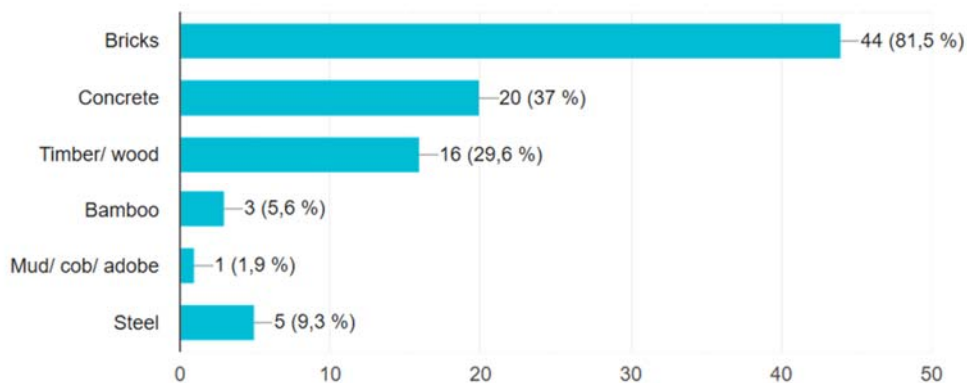


FIGURE 44 - PERCENTAGE OF PEOPLE SELECTING THE MATERIALS COMPOSING THEIR NEIGHBOURS' HOUSES

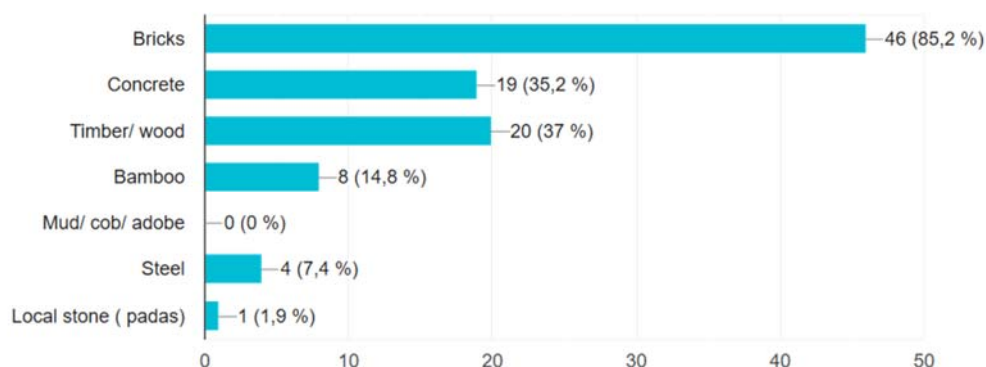


FIGURE 45 - PERCENTAGE OF PEOPLE SELECTING MATERIALS FOR THEIR IDEAL NEW BUILDING

It is clear that bricks, concrete and wood are the materials that have the most success, even for the participants' "dreamed new building" (Figure 45). People answering this survey most commonly refer to brick and 85.2% of the people answering this questionnaire would still use it for an ideal new construction with no limited budget.

4.1.3. PERCEPTION *A PRIORI* OF BAMBOO AS A CONSTRUCTION MATERIAL FOR HOUSING

Whereas only 14.8% of the participants did choose bamboo as one of the possible construction material for an ideal new building (Figure 45), when asked further and more specifically if they would like their new extension to be made of bamboo, 51% nevertheless answered "Yes" (Figure 46). It is almost as if 36% of them had first not even considered bamboo as a possible option among other materials suggested in the list, but later changed their minds.

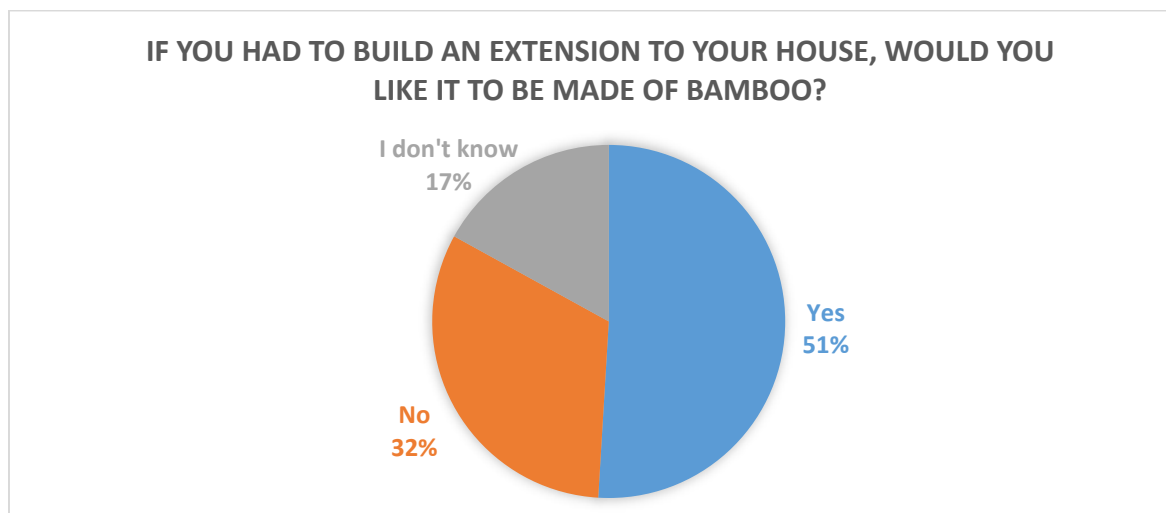


FIGURE 46 - PERCENTAGES OF PEOPLE ANSWERING THE QUESTION

As we have seen before in the state-of-the-art (Kim, 2015), the age and background of the person might influence their state of acceptance of a technology (e.g. bamboo construction). Thus we decided to cross the data with the ages of the participants and their originating district, to see if the level of acceptability of bamboo construction has something to do with these. In this case, we have the graph in Figure 47.

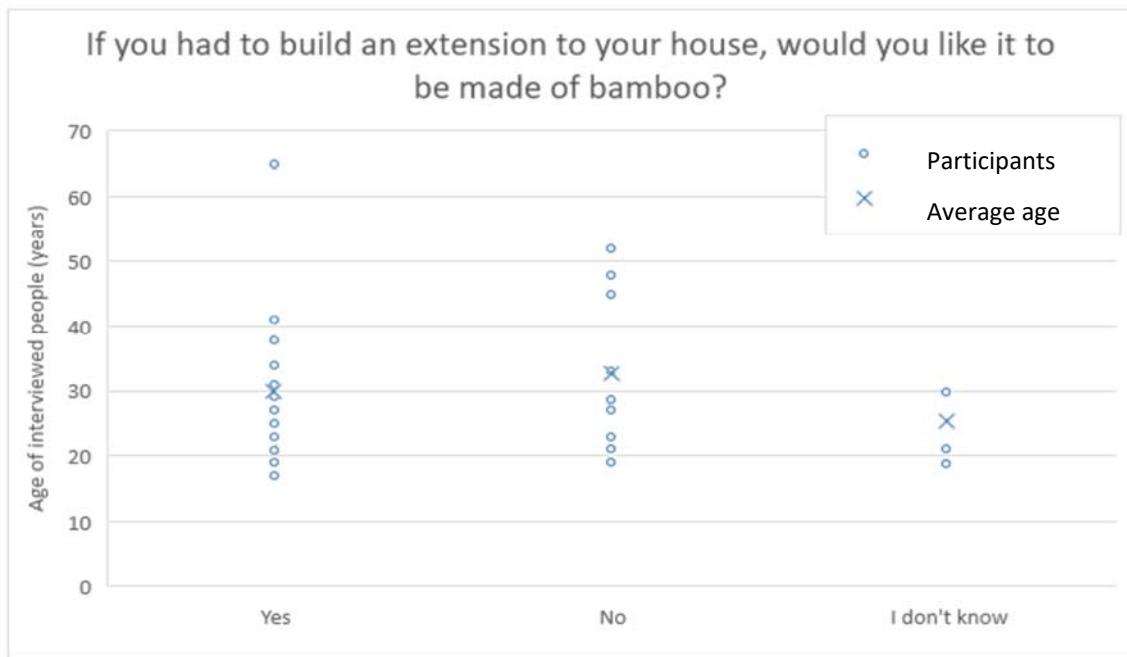


FIGURE 47 - ANSWERS TO THE QUESTION AS A FUNCTION OF THE AGE OF THE PARTICIPANTS

As the Figure 47 shows, the averaged ages of participants answering “Yes”, “No” and “I don’t know” are substantially the same. There is accordingly no reason to think that the age influences the perception of building a bamboo construction. Yet, we notice that participants answering “I don’t know” are rather young, perhaps as they do not yet see themselves owning a house.

Looking into other factors influencing the perception, we also crossed the data of the answers to this question with the districts people were coming from. The graphic thus obtained (Figure 48) shows that Denpasar is the only district where more people answer “No” than “Yes”. However, as the sample is not very large, no firm conclusion can really be reached here.

As for the following points of interest, the originating district will not be considered anymore as there is nothing we can deduct from a sample this small, especially for the districts of Bangli, Jembrana and Tabanan, were fewer than three people answered. However, the diagrams can be found in Appendix V.1.

The “Other” column corresponds to Indonesian people originating from other islands.

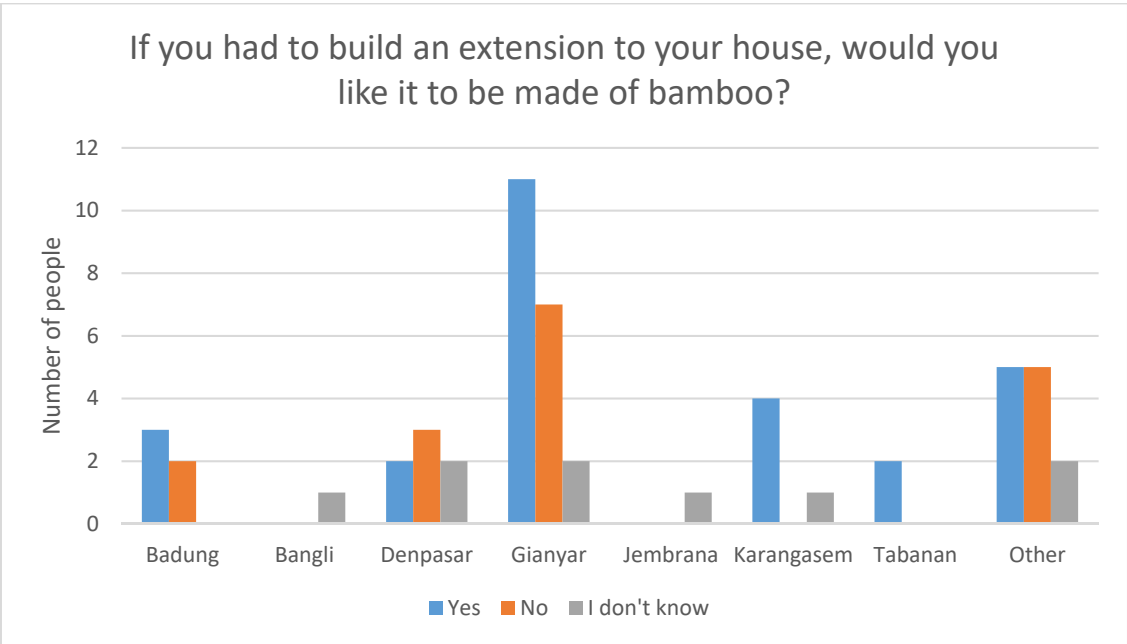


FIGURE 48 - ANSWERS TO THE QUESTION AS A FUNCTION OF THE DISTRICT OF THE PARTICIPANTS

Further on in the questionnaire, targeting the perception of the cost of materials, participants are asked to rank bamboo as “the cheapest of construction materials”, “cheap”, “affordable”, “expensive”, “the most expensive of construction materials” or “I have no idea”. To simplify the obtained data, we group “cheap” and “cheapest” as well as “expensive” and “the most expensive”. The following diagram presents the proportions of answers obtained (Figure 49).

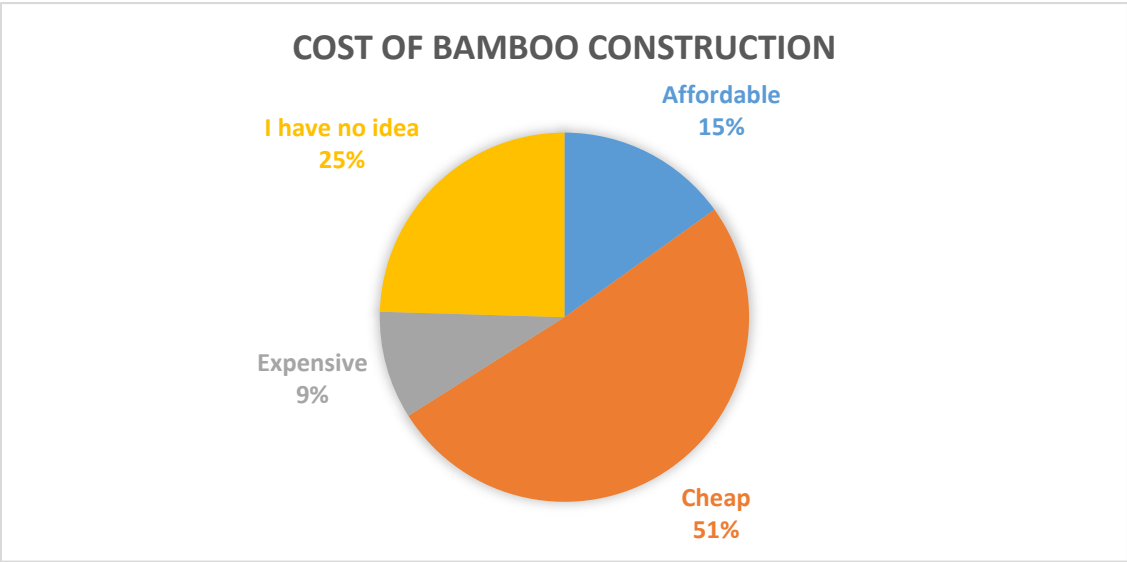


FIGURE 49 - PERCENTAGES OF PEOPLE, REGARDING THE COST OF BAMBOO CONSTRUCTIONS

Most people tend to think that bamboo is cheap. Together with people thinking bamboo construction is affordable, they constitute a large majority. Moreover, a quarter of the people answering this question just do not know at all about the range of cost of bamboo construction.

Just as for the acceptability level we mentioned before, we cross the data of the perception of cost with the age and originating district to establish a possible influence of these factors (Figure 50).



FIGURE 50 - PERCEPTION OF THE COST OF BAMBOO CONSTRUCTION AS A FUNCTION OF THE AGE OF THE PARTICIPANTS

Here again, the averaged ages of participants answering each category are substantially the same. Therefore, there is no reason to think that age influences the perception of the cost of bamboo construction, at least in regard to our limited sample.

Regarding the cost, the occupation of the participants might have an influence on their perceptions. The different jobs mentioned by people in the questionnaire are gathered in ten general fields in order to clarify the graph (Figure 51).

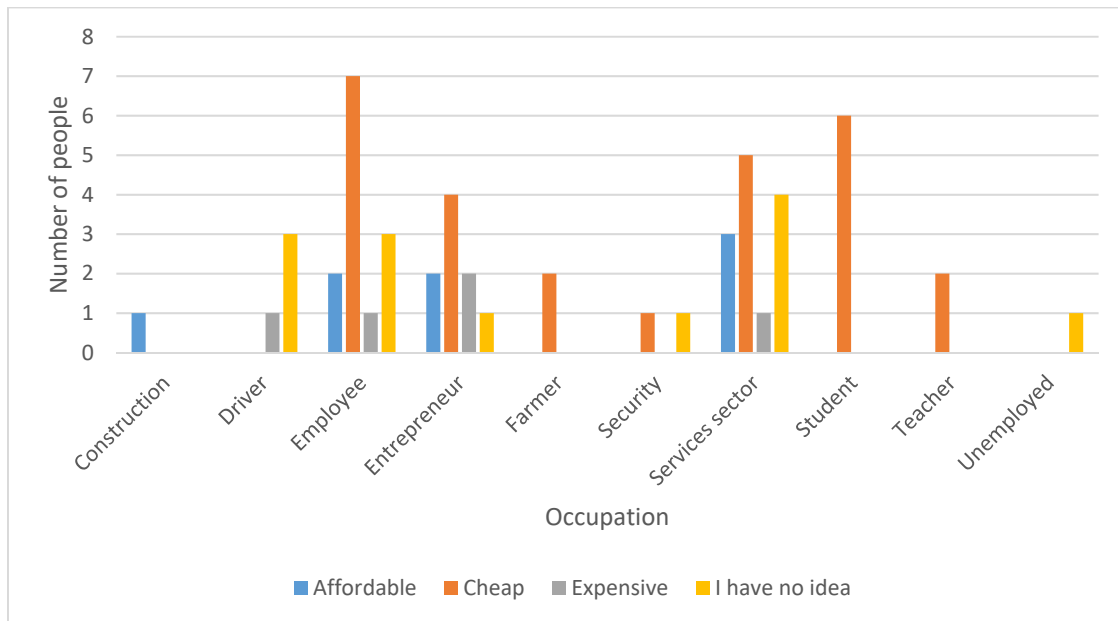


FIGURE 51 - PERCEPTION OF THE COST OF BAMBOO CONSTRUCTION AS A FUNCTION OF THE OCCUPATION OF THE PARTICIPANTS

We observe that the people pursuing a deeper education path (students and teachers) tend to be all quite certain that bamboo is cheap. The few farmers participating in this survey agree with that. The person working in the field of construction has a more evened opinion thinking bamboo construction is affordable. In other fields, the points of views vary a lot from one person to another.

Regarding the perception of the lifespan of a bamboo construction, here are the proportions of people answering each range of duration (Figure 52).

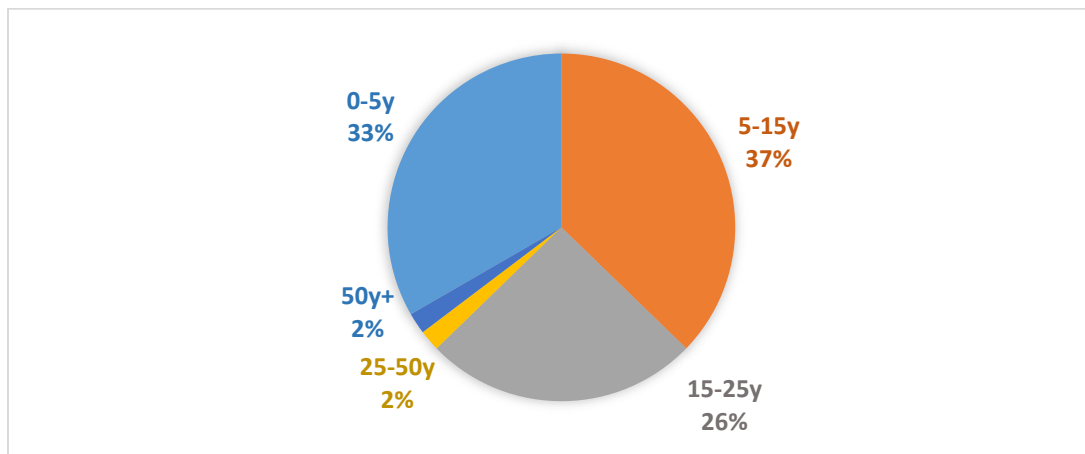


FIGURE 52 - PERCENTAGE OF PEOPLE REGARDING THE PERCEIVED LIFESPAN OF A BAMBOO HOUSE

0-5Y : LIFESPAN OF 0 TO 5 YEARS

5-15Y : LIFESPAN OF 5 TO 15 YEARS

15-25Y : LIFESPAN OF 15 TO 25 YEARS

25-50Y : LIFESPAN OF 25 TO 50 YEARS

50Y+ : LIFESPAN LONGER THAN 50 YEARS

Once again, the average ages of participants who answer each range of lifespan are similar (Figure 53).

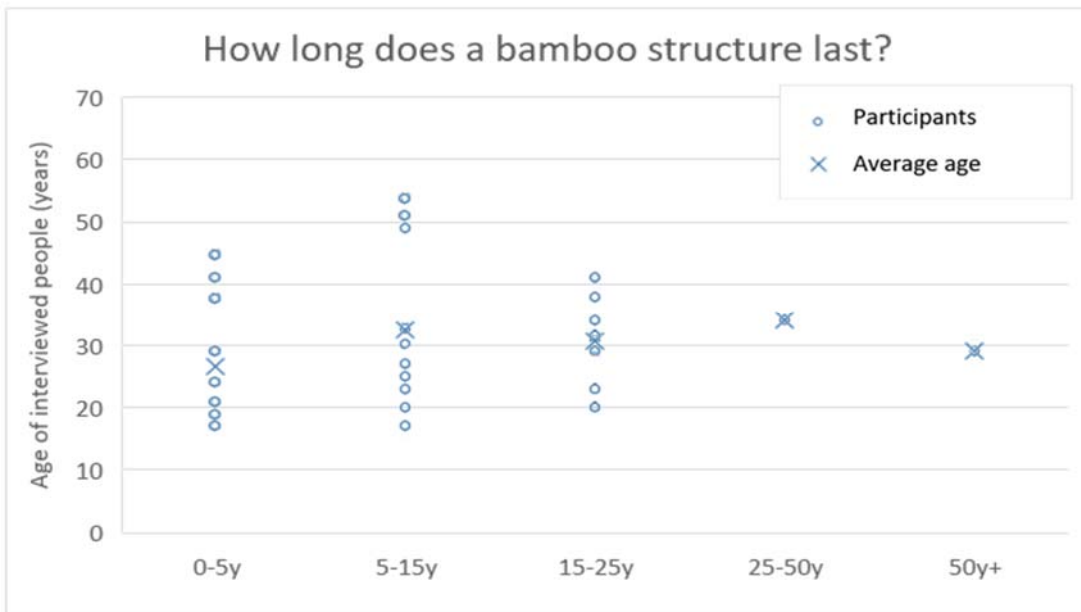


FIGURE 53 - PERCEPTION OF THE LIFESPAN OF A BAMBOO HOUSE AS A FUNCTION OF THE AGE OF THE PARTICIPANTS

Finally, we check if knowing someone who owns a bamboo house has an influence on the perception of the lifespan participants have, perhaps relying on the examples they know about (Figure 54).

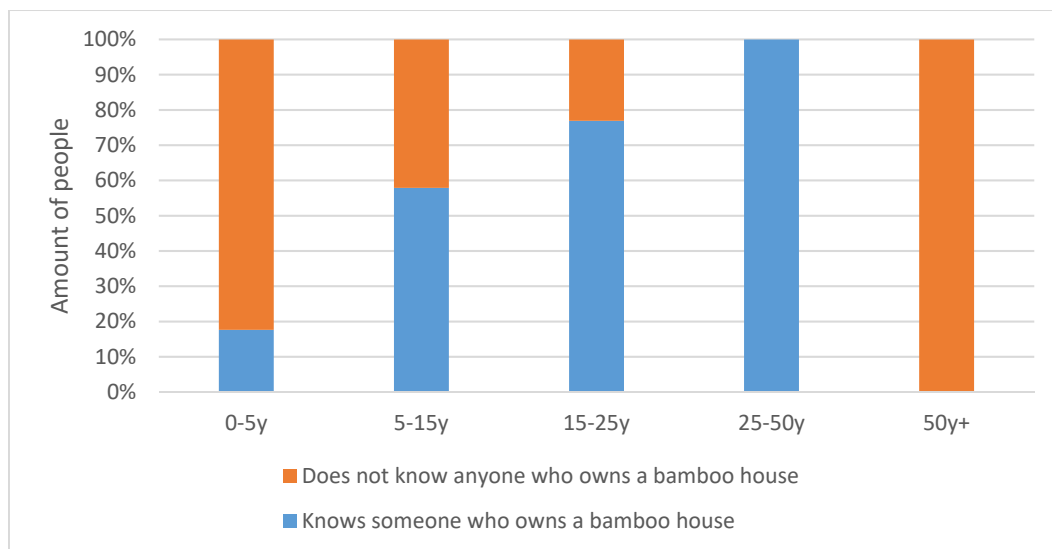


FIGURE 54 - PROPORTION FOR EACH LIFESPAN RANG ANSWERS OF PEOPLE KNOWING S.O. WHO OWNS A BAMBOO HOUSE VS. NOT

As only one person answered “25 to 50 years” and one “more than 50 years”, we do not take those two into account. We then focus on the other results. We can notice that people thinking that bamboo has a very short lifespan are mostly people who do not know anyone owning a bamboo house. The perception of a longer lifespan increases with the percentage of people knowing the owner of a bamboo house. However, this

only goes as far as 25 years of duration, as already mentioned, as only two people answering this study thought bamboo could last longer.

4.1.4. KEY TOPICS ADDRESSED

The diagram on the next page (Figure 56) sums up the occurrences of utterances targeting these topics. We will use them as a base for some qualitative indicators for bamboo housing. These utterances were collected through the following questions:

- Name the first 3 words that come into your mind referring to bamboo houses ;
- [If you had to build an extension to your house, would you like it to be made of bamboo? Yes, at one condition] Describe the condition ;
- If you would not have your extension built in bamboo, explain why ;
- From your point of view, what are the pros (advantages) and cons (disadvantages) of bamboo construction? ;
- [Do you know anyone who owns a bamboo-building?] If so, what do you think about it?

The keywords having the greater amount of occurrences are the following (the bigger the size of the font, the most the topic is mentioned throughout the questionnaire):



FIGURE 55 - WORD CLOUD OF THE UTTERANCES

It should be noted that, to interpret these results, the research shall pay attention to the context these words have been written in, by going back to the answers where these words are mentioned and to the corresponding questions.

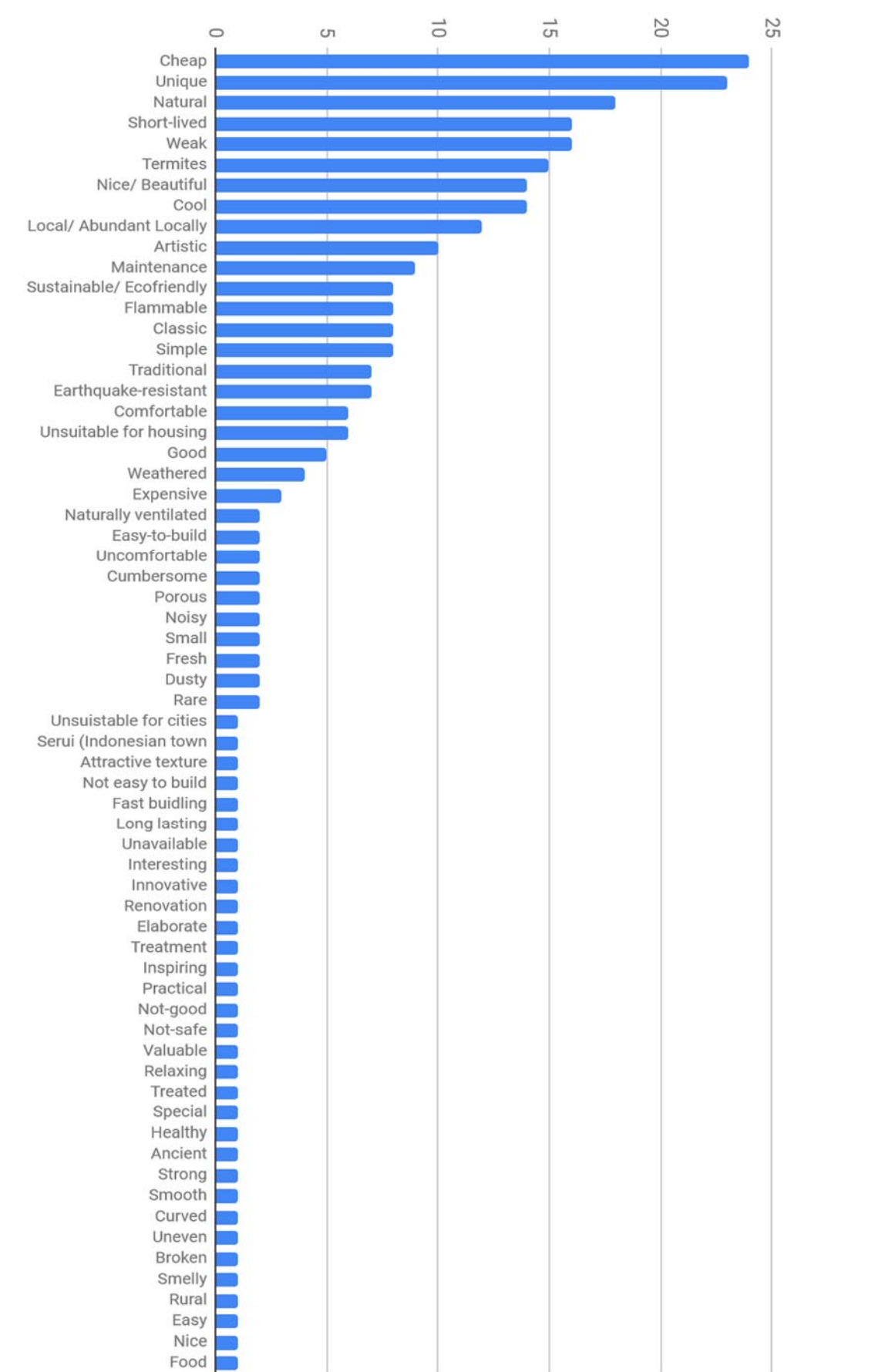


FIGURE 56 - OCCURRENCE OF UTTERANCES TARGETING KEY TOPICS FOR QUALITATIVE INDICATORS FOR BAMBOO HOUSING, COLLECTED THROUGH THE WHOLE QUESTIONNAIRE

The survey questionnaire answers count a **large panel** of profiles. It aims to evaluate their perception *a priori*.

Bamboo is not the reference material for Balinese people. The participants in the survey are **divided** regarding acceptance of the material: about half of them could consider bamboo for a new construction.

Most people think it is **cheap** or at **least affordable**.

Regarding the **lifespan** of the material, it depends on whether or not the person knows a bamboo house owner. We can also add that there are not many people thinking a bamboo house could last more than **25 years**, contrary to what the state-of-the-art suggests.

The **keywords** in the survey, which can be a base for **qualitative indicators**, are listed in the word cloud in Figure 55. However, the context they are mentioned in will be checked to interpret these results. Moreover, this ground base will further be crossed with the state-of-the-art and the other methods' results.

4.2. IN-DEPTH INTERVIEWS A PRIORI

The analysis of these studies has two main objectives which are (i) to discover how users consider the bamboo construction, in particular for housing and (ii) to collect the criteria/indicators on which they base their opinion to qualify the space.

The consideration expressed comes only in second place of interest but nevertheless allows to assess briefly the state of acceptance the interviewee is at, considering the material.

The transcripts of these interviews can be found in Appendices I, L, O and R.

This section presents the interviewee and highlights the comments that can describe qualitative indicators influencing the perception the user has of what a bamboo house is like, whether or not it might be a suitable structural material for a house to live in and why. A "profile" description synthesizing the profile of each user is summarized, emphasizing the perception each participant has on the matter. Finally, the comments of same nature are grouped together, crossed between the various users and compared.

4.2.1. IN-DEPTH INTERVIEW OF AYU SIMPANI

Ayu Simpani is a 30-year-old **accountant** working at Asali Bali. She lives alone in Gianyar. Her home is a four-room-apartment in a two-storey-building made of concrete, wood and tiles. She is **not fluent in English**, she had some difficulties understanding the questions asked throughout the interview.

Her **references** in terms of materials are **concrete**, **wood** and **brick**. For a new ideal construction of hers, she would firstly choose **concrete**, because it is **long-lasting**, and **wood**, because it is **traditional**, according to her.

Pertaining to bamboo, the key words she uses are "**good**", "**back to nature**", "**cheap**", "**earthquake resistant**" and "**fast-growing**". She considers it to be cheaper than

concrete and wood. In her opinion, the lifespan of a bamboo construction is 20 years, which is not long enough to her opinion.

Regarding the aspect of the materials, she mentions that brick and bamboo are the prettiest to her, rather than concrete, but that she **favours a durable construction over the looks of it**.

Ayu also mentions alang-alang, a bamboo by-product used for roofing she really likes.

For the photo-elicitation step, she chooses the following pictures (the total sample of photos is available in Appendix C.3.) :



The first one is selected for its **natural look**, the **curves** of the walls, the **colours** and the **lightness** of the room. She associates it with a bedroom-like atmosphere she would like for her own bedroom.



The second picture she wants to talk about is this one. She feels like the **light** would not properly enter the bungalow and thus really do not like it. She really insists on the fact that apertures are an essential factor to ensure the quality of a space.



Finally, this photo is elected for the unique shape of the building and the **forestry outdoor context**. She can picture herself having a kitchen like this in a traditional Balinese compound.

Ayu is a shy person. She is really trying to do well by the interviewer.

She talks a lot about the fact that bamboo is a way of **reconnecting with nature**, that it is **environmentally friendly** because it grows fast, and is **cheap**. However, she does not seem fond of it as a structural material for housing as, in her opinion, it is **not durable enough**. She thus prefers concrete. She also mentions liking wood very much because it suits Balinese **traditional** style.

She insists on the **brightness** of spaces which is important to her and the fact that she really likes the **natural look** and **colours** of bamboo finished spaces.

4.2.2. IN-DEPTH INTERVIEW OF ADE PARMITHA

Ade Parmitha is a 21-year-old student at University of Mahasaraswati Denpasar, majoring in English literature. She has a **good English level**. She lives in **Denpasar** with her family. Her home is a dense compound consisting of three sleeping pavilions. She also tell us about the Sanggah Kemulan, the small-scale temple for the daily offerings of the family on the second floor above the Bale Dangin. Together with her family - her mother, father and two sisters - she spends a lot of time on the porch in front of the Dangin common pavilion, which is used as a living space.

She explains the pavilions composing her house are made from **brick** and **concrete**, with **wooden** and **bamboo** frameworks and **tiles** on top. The Dangin pavilion has a weaved bamboo ceiling. According to her, that ceiling is leaking and getting really mouldy.

For a new construction of hers, she would still go with concrete but says she thinks it might have something to do with the mould as a concrete house, unequipped with modern technologies such as air-conditioning, is not **healthy**. Nevertheless, her bedroom is already full concrete and she seems satisfied with it.

Pertaining to bamboo construction, she mentioned that, in her opinion, bamboo is a material of the past. It is comfortable to live in but it is “**for old Balinese people**”.

In her family, her grandfather used to have a bamboo house. He lived in the **countryside** and bamboo was **very cheap**, way cheaper than concrete. So, it is good for villagers, she concludes. However, for the millennials in cities, she does not believe there is a future for wood and bamboo.

If someone was building a bamboo house in the city, she says, it might be seen as **unique** and **original** but what about the long term? She also mentions the fact that for a hot climate like in town, it is too hot to build with bamboo, so **concrete and air-conditioning** are the way to go. According to her, the lifespan of a bamboo construction is only two years. It is good for furniture **but not for actual construction**.

The keywords she uses are “**environment-friendly**”, “**cheaper**” and also mentioned it “**supports the local craftsmanship of Bali**”. However, she also outlines the fact that, in her opinion, it is a **short-lived** material that is best for scaffoldings.



Regarding the photo-elicitation, she chooses the following pictures:

Ade likes this small **resting** pavilion. She can picture herself relaxing there with her family. This is typically the kind of porch you might find in front of a Bali Dangin or at the very front of the compound, close to the street.



She loves this one, especially the **alang-alang** for the roof of the house. She can picture a “comfy” interior to this house but still states that this is the kind of house you would like to have in the countryside and not in the city. She still mentions **she would like to live in this kind of house later on, if she moves back to her birth town in Gianyar.**



When asked to select a picture she do not like, this is the one she chooses. She does not like the roof of it. She had troubles putting it into words but did insist on not liking it at all, and rather shows the previous one saying she preferred it.



Finally, she wants to pick a fourth picture and chooses to take this living room. What gets her attention is the **furniture**. It gets her talking about a sofa like this one that her grandfather bought and that she thought was very “**comfy**”, she says. She likes the atmosphere of this picture, the **natural colours** and the full bamboo look going down to details and even the stairs. She also describes it as “very tidy”.

Ade is an **urban millennial** girl from an upper-middle class family allowing her to pursue her studies.

The mental image she has of bamboo *a priori* puts it as an **old people’s material**, unsuitable for the modern needs. She thinks it is a **healthy, cheap** and **environmentally friendly material** that could fit in the **countryside for villagers** but not for the urban population except if it is for **furniture and decorations**. In her opinion, bamboo is **not durable** and does **not** give the possibility to be **air-tight** enough to install air-conditioning.

However, when she actually sees the picture of examples she likes, she says she would like to live in a house like that **someday**, perhaps when moving back to the countryside. She seems to like curved-wall houses with alang-alang roof, describing these as **comfortable** and **natural**.

4.2.3. IN-DEPTH INTERVIEW OF DEVI MARIANI

Devi Mariani is a 22-year-old employee in the field of hospitality. She lives with her family, parents and a brother in Sanur, Denpasar. Her home is a six-room concrete building. She is a **novice in English** but is really trying to move ahead. She really wants to participate in this study. Thus, throughout the interview, we fell back on an electronic translator and some of her answers are recorded in Indonesian. These slots of the recording are translated thanks to the help of an Indonesian volunteer, fluent in English.

Her **reference** in terms of material is **concrete**. In her opinion, it is the **cheapest**. Further on, comparing concrete, brick and bamboo, Devi ranks brick and concrete as cheapest and **bamboo and wood as more expensive**.

For a new ideal construction of hers, she would choose wood (e.g. “trees”, she says). She mentions she really likes teak.

Pertaining to bamboo, the first thing coming to her mind is that it is used for kites, canalizations and for frameworks. She also mentions, in Indonesian, that she likes it for the relaxing spot, to hang out with her family.

Devi states **she would not use bamboo for a new construction of hers**. But when asked about the factors of this refusal, she tempers her answer saying **she might try** bamboo construction **someday** because it might be “interesting”. Then, when asked about the **lifespan** of bamboo construction, she says it might last **5 years, maybe 10**, but says that it is good and **strong**. She also adds that it can get **infested with termites** and get **dusty** and dirty.

For the photo-elicitation step, she chooses the following pictures:



She first chooses this picture, asking about the materials it is made of. The researcher answers her curiosity, telling her about the adobe and the possibility of working with both **adobe and bamboo**. She then goes on saying she likes the **looks** of it, the **shape** and **colours**.



Devi then chooses this image and speaks about it in Indonesian. What we are able to translate is about this being a nice **relaxing place** to meet up with friends and family.



The last picture she chooses is this one. Once again, she likes the looks of it, and insists in the **alang-alang** that is “**neat**” and “**simple**”.

Communication with Devi is hard for a non-Indonesian-speaking researcher. However, we still manage to have a conversation. Devi is a lower-middle class young girl working already but still living with her family.

She pictures bamboo as a luxurious, **expensive material**. She does not really seem to have a forged opinion on whether or not she would like to live in a bamboo house, she seems to answer what she thinks the interviewer wants to hear.

Regarding the **lifespan** of bamboo construction, she says it might last **5 to 10 years**. She has concerns about **termites** and **dust** in bamboo houses.

4.2.4. IN-DEPTH INTERVIEW OF NGURAH WIDI

Ngurah Widi is a 65-year-old man retired from the educational department sector. He lives in Badung with his wife and granddaughter but also has a place in the city, in Denpasar. In his house in Abiansema, Badung, where this interview took place, he has all commodities such as a kitchen, dining room, a bedroom and a bathroom. He also owns a corner grocery shop and two guests houses which he rents. All of these buildings are made of brick, concrete, timber and tiles.

The procedure of the interview is shaken by the fact that Ngurah really insisted on reading the questions before the beginning of the interview. This was only accepted as his level of English and hearing abilities were a little low. Thus he knew the subject suggested by the handbook in advance.

His **references** in terms of materials are **bricks** and **wood** for the city, he mentions that **bamboo is widely used in the countryside**. We recall that, as he knew the questions to come were about bamboo, this might have influenced his answers. The interview being flexible, this was an opportunity of bouncing back on the subject and digging in his point of view regarding bamboo construction.

According to him, bamboo buildings are healthier than brick and timber buildings but are also **weaker**. By weaker, he means **less durable**. Indeed, he estimates the lifespan of bamboo as being about **15 to 20 years**. He expects a brick construction to last at least 30 years. He states that **in Bali, we use raw bamboo untreated** “by chemistry” (in his words) because it is not natural to treat it. Bamboo thus gets **dusty and infested with insects**. He thinks bamboo is **artistic** and **natural**, and would support neighbours building with bamboo, but he still thinks it does not last long enough and adds that the maintenance costs would be too expensive for him. The material is **cheap** to buy and build, cheaper than concrete and brick, but the **maintenance brings up the costs**.

For a new ideal construction, he would rather use brick and wood “because it is easier to take care of”.

Ngurah also mentions the fact that everyone is allowed to build with bamboo, there is **no restriction** of that kind by the government. He even goes further saying it is **encouraged by the authorities** to build with such a natural material. “It depends on the material they can find in the area” he says.



For the photo-elicitation step, he chooses the following pictures:

To him, these three pictures (chosen all at once) have nice **shapes** and **colours**. Altogether they look very artistic and natural. It tends to bring people closer with nature and the forest, he says. He adds that bamboo is “**good**” and “**healthy**”.



Ngurah is a pretty wealthy retired man, who owns two houses and recently retired from the educational sector who still works as a host and owns a grocery store.

He sees bamboo as a **nice and healthy natural** material, which is **appropriate for the countryside** but not durable enough and too expensive to take care of. He is concerned about **insect attacks** and the **dust** it brings in.

He mentions the fact that there is no restriction for bamboo construction and that it is even **encouraged by the authorities**.

Altogether, this shows how the perception of bamboo construction can vary from an individual to another.

Concerns about the **lifespan** of bamboo constructions are a recurring problematic, even though the estimated duration of a bamboo building varies a lot, here going from 2 to 30 years depending on who you ask.

The **perception of the cost** of bamboo construction is rather ambivalent: throughout these interviews, we realized some people see it as a very cheap material whereas another might see it as expensive, even luxurious.

The reliability of bamboo as a strong material is also discussed by some of the interviewees, some of them saying it is a **strong**, some of them saying it is **weak**. Some also evoke the **earthquake-resistance** characteristic of bamboo construction.

All participants say they are fond of the **curvy shapes** and **natural look** of bamboo. Some even go further saying it brings the users closer to nature.

4.3. COMMENTED WALK

Just as for the in-depth interviews, the transcriptions of the comments made by the participants throughout the walks can be found in the appendices J, M, P and S. Pictures of the visited buildings are available in Appendix V.2.

Here, the stake is once again to highlight any comments made regarding the perception of the material. For each user, we note the words that seem to be relevant to determine what is perceived or experienced by the user and how.

In the end, we wish to obtain a list of criteria users employ to characterize the spaces. This list is not exhaustive, it is directly related to the perceptions that have been made, in regard of the site and to the users involved. These sensitive criteria can be the baseline for qualitative indicators for bamboo housing, broadening the criteria collected by other means, in this case the survey and in-depth interviews.

It should be mentioned that the visits took place in March on very hot and humid days.

Throughout all of these commented walks, an element got in the way of the protocol as it should have been: during the visit of the house, the owner was not supposed to be around as agreed with him upstream. However, due to unexpected circumstances, he was there, each and every time. Nonetheless, beside the bias it created, this led to very rich interactions between the owner and curious participants asking him questions.

4.3.1. COMMENTED WALK OF AYU

In Ayu's scenario, the little pavilion is her bedroom. She uses the word "**natural**" a lot to describe the place. She does not find it too noisy although just before going inside we could hear people working outside. She says she **likes the air** and smell there too. The only thing she is complaining about is the slight lack of light. In her opinion, the door could also be glass or a mirror to make the space look **brighter**.

When the researcher goes ahead and touches the bamboo and adobe wall, so does she and she says she likes the texture of it. She then describes it as a way to connect with nature. She emphasizes the fact that it is cheap but also safe because it is earthquake resistant, she says.

Entering the second building visited, Ayu really expresses astonishment (see Appendix J, after the 07min34sec comment: long "wow"). She does not really seem to be able to put it into words. She repeats it is nice. When asked if it is the colours or the shape, she just answers "Yeah" and "Good". When asked about what she did not like, she just says that she does not know. Again she states the fact it feels strong and safe.

Upstairs, she mentions once again a lack of light in her opinion. She also raises the fact that it is too hot in there.

However, she still mentions she would like a bedroom like this house. At last, going around the kitchen, she adds that it "feels nice and also good for life". She still adds that it is not durable and that maintenance would be too expensive.

Ayu's commented walk emphasizes aspects of bamboo construction she already mentioned in the in-depth interview: the natural look of bamboo she likes, the need for bright spaces, and the fact she thinks bamboo contributes to making a place healthier.

The **sensory factor** she adds is the sensation of **fresh air** circulation inside while keeping out the noises and smells. She also says that **touching** the material helps her **connect with nature**. She also mentions that she is feeling **too hot** upstairs.

4.3.2. COMMENTED WALK OF ADE

Ade pictures a new kitchen in the first pavilion. The aspect she first mentions is that she would need a lamp in there. She really pictures herself there, imagining how she could furnish it. She then starts commenting the building.

First, she mistakes the adobe for concrete, then thinks it is wood. When the researcher explains what it is, **she touches** it, impressed. She then goes on about the **natural air circulation** in the small pavilion, complimenting it.

Then touching the bamboo, switching between knocking on it and fondling it, she asks if it is strong enough or if there is steel reinforcement inside of it. When told otherwise,

she knocks on it one last time stating “This is **strong enough** for me. Yes, it is good overall I really like it. It is the first time I saw this.”

Walking in the second building of the commented walk, she suddenly stops, amazed. She exclaims a couple of times “wow”, “waw” etc., mentioning she likes the sofa, the smell (the owner was cooking), the outdoor bathrooms and the alang-alang. She mentions concerns about the **alang-alang leaking and smelling when it rains**, going up to the owner and asking about it. The owner tells her that the house has only been treated once, when it was built 10 years ago, with “Borax” and that since, the only thing needing maintenance is the roof, alang-alang needing to be replaced every 5 years or so. He also explained to her, when she asked, that the house does not get mouldy. Ade then mentioned why she thought it would only last two years then get eaten by termites. The owner then tells her about the treatment of bamboo for it to be insect-proof.

Ade emphasises keywords such as “natural”, “unique” and “comfy”. She mentions that she loves it but is not sure it would be suitable for the city.

She still does not fully trust the strength of the bamboo, commenting while going up the stairs “Is that strong enough for me? I'm a little scared. So this is all of bamboo, no iron maybe inside?” She compares it to concrete, saying that this feels “comfy” but is cheaper than concrete whilst still giving a sense of luxury.

Ade addresses **sensory comments** expressing surprise a lot throughout the whole visit. She mentions the natural brightness of both places, the natural air flow in the spaces.

She also **touches** the materials a lot: the adobe first, wondering what it is, then the bamboo, trying to figure out how strong it is, in a way, shifting from insecurity about the **reliability** of bamboo as a structural material to **trust** in the material, saying it is strong enough for her and that she feels comfortable in these spaces and that it gives **a sense of luxury** while still having a very **natural look**.

4.3.3. COMMENTED WALK OF DEVI

For the first pavilion, Devi pictures a new bedroom for herself. She judges it a little small, “good” and “simple” she says. She furnishes it in her mind, describing the position of things she would put in there. She says the ambiance there makes her feel comfortable and lonely. While developing the lonely feeling, she describes more as a nice place to have some “me-time”, resting **peaceful time**.

Touching the bamboo, she says “good but **not smooth enough**” in her opinion. She also mentions she would add a light inside but just for the night-time as she noticed there was none.

Going on to the next building, she is welcomed by the owner. She raises the fact the smell is nice and she feels comfortable, even says she would very much like to take a

nap there. She mentions the **shape** of the room with the mezzanine she likes. Then the **light**, saying once again it is “good”.

“Maybe someday when I grow up I can live in a place like that. (...) I feel like I want to have a home like this” she adds.

Now in the house, **touching** the ramp of the stairs, she states that it is **really smooth**, better than the finishing in the first building visited. She mentions the cracking sound of the flooring on the top floor and in the stairs but still insists that she barely hears it.

Spontaneously, while visiting the bedroom, she says she feels **fresh**, not too cold nor too warm.

She did not like the outside bathrooms so much: the natural “mossy” look makes the mosquito come, she says.

Devi can easily picture herself living in the visited spaces. She describes the atmosphere giving her a **sense of peace** and appeasement, saying she someday may want to live in a similar building.

She touches both the bamboo in the first and second visited buildings and says the first one is **not smooth enough** and that she enjoys touching the bamboo in the second one as it is much **smoother**. She also mentions the **thermal comfort** of the space and freshness of it.

4.3.4. COMMENTED WALK OF NGURAH

Ngurah did not get in the role play so much, asking the current actual function of the pavilion, used as storage. To him, as it is not very clean, a little dusty even, it is not healthy. However, he mentions that if cleaned this would be a very **healthy** building with the openings in the ceiling allowing air to circulate and the alang-alang roof playing a role in keeping the building at a comfortable temperature. He also mentions the **maintenance** this type of roofs needs, being changed every couple of years.

He says he likes the **natural look**, the adobe and bamboo together, asking if there is no reinforcement inside the wall. He adds that, in his opinion, mud also helps keep a **nice temperature inside** as in his grandfather’s house. He then goes on about the fact that he thinks it is **suitable for the countryside** but not in the city because the people living there dislike these materials.

Continuing the commented walk and going to the bamboo house, we run into the owner. Ngurah tells him the house is very **artistic** and **natural**. He asks if there is air-conditioning. The owner answers it does not. Thus Ngurah says the house is **healthy, surprisingly fresh** and **natural**.

Then, Ngurah says that he thinks this type of house is way **too expensive**. Explaining his thought, he goes on about the **maintenance**: taking care of a house like this, he says,

takes up a lot of money. It is cheap when you build it but then, costs in the long term are too high. The owner discusses with him the fact that a concrete house needs maintenance, too. The two settle saying that costs are similar for the maintenance of these two types of buildings except for the *alang-alang* roof which has to be often replaced and is thus very expensive to take care of.

Going upstairs, Ngurah gets worried about the fact the flooring might be slippery.

Further on, he mentions his grandparents who used to have a bamboo house. “Because they used to stay in bamboo buildings, I think I just wanted to make a new one” he says. Then speaking about it, he gets a little nostalgic, saying how **comfortable** and “good” he feels.

He states he likes the **air quality** in the building but that the **airtightness not being so good**, he would not like to live in a house like this for more than a two-month-holiday. The dust and mosquito can easily get in, he says.

Ngurah repeats some of the comments he already addressed in the in-depth interview before. However, here, there is an interesting discussion happening between the owner of the house and the interviewee: indeed, the owner gets Ngurah to compare the **maintenance costs** of a concrete house with the ones he pictures for a bamboo one. They both conclude that the expensive thing about the house is the **alang-alang roof**.

This experience brought back some memories for Ngurah: he recalls that, as the older generation in his family used to build in bamboo, when he started his own household, he wanted a **renewal** in the materials he chose. The visit also reminds him how **comfortable** he used to feel in a bamboo space.

The sensory approach brings Ngurah to say he feels **surprisingly fresh**, comfortable and that he likes the **air quality** of the space. However, the **lack of airtightness** bothers him.

Throughout the commented walks, **sensory comments** are addressed by the participants. They evoke the natural air circulation, textures, thermal comfort. They also mention light characteristics and smells. Furthermore, some of them mention more specific feelings perceived regarding **topics** such as perceived safety, general comfort and a sense of appeasement.

4.4. IN-DEPTH INTERVIEWS *A POSTERIORI*

Now again, the process is very similar to the data processing of the interview *a priori*, whereas the stake is going to be in comparing both the perceptions before and after the commented walk whilst still maybe adding some information to the caricatured descriptions of the interviewees' profiles.

4.4.1. IN-DEPTH INTERVIEW OF AYU

At this stage of the process, Ayu expressed feeling happy. She felt connected with nature there and thrilled to see a house like that, she described it as "a new experience". It should be mentioned that Ayu works at Asali Bali and thus has already seen bamboo buildings before.

She mentions the fact that the rest of her family would not like her to live in a bamboo house because they have never seen one like the one we visited. She adds that they do not like bamboo because it does not last long enough. However, she would argue with someone hesitating that "It's really good for you. A good resistance. Cheaper than concrete and steel or what." She estimates the Owner's house at 2.5 million per square metre, thus about 200 million rupiahs (12 500€).

Now after the commented walk, Ayu still thinks that a bamboo house only lasts 20 years. Nevertheless, she said she changed her mind about someday owning a bamboo building: she would like a bamboo bedroom because it is natural and beautiful. She states that usually, when visiting a bamboo building, she just sees the building as work. But this was the first time she saw a home, the first time she really thought it was beautiful and, above all, the first time someone had asked her to stop for a minute and ask herself how she felt about the place, how she perceived it etc. and that approach made her realize she likes it.

Ayu states that the commented walk made her change her mind about bamboo houses. Even though she **does not give much different answers** to the questions that were already asked before, she still says it opened her eyes on **a new way of appreciating** it and that she would therefore consider having a **bamboo bedroom**.

4.4.2. IN-DEPTH INTERVIEW OF ADE

Ade explains how excited she was during the visit. When asked again if she would like to build a bamboo house, she answered that, moving back to her birth town, she would like to build with bamboo if she is able to have it treated.

After discussing with the owner, she now thinks that a bamboo construction can last more than 10 years, maybe even more than 20 she says. She now supports that bamboo, being environment-friendly, cheap and empowering local bamboo farming and craftsmanship, promotes a local Balinese material.

She estimates the owner's house at about 15 million rupiahs (about 950€), "not too expensive" according to her.

She also adds that she is interested in combining materials to build houses, for instance wood, stone and bamboo, she says, **promoting local know-how**.

After the visit and the discussion that she had with the owner of the house, Ade's opinion on bamboo **changed a lot**.

For instance, she thought in the *a priori* interview that a bamboo house could only last about 2 years. She is now saying it could last **20 years**.

She now states she would like, someday, to live in a bamboo house, still not in the city but moving back to a **suburb area**.

4.4.3. IN-DEPTH INTERVIEW OF DEVI

After the commented walk, Devi is asked if she would build in bamboo for a house of her own. Her answer is direct: "Yes, I will someday." She explains that she used to think it could not last long at all, but seeing a 10-year-old house so neat reassured her. So her concerns vanished, she really likes the looks of raw bamboo buildings thus she would like to build in bamboo someday, outside of the city, she says.

She also says that she would recommend bamboo to her neighbours, for example for a relaxing pavilion.

Asked again about the lifespan of bamboo, she hesitates. She says she wants to say 10 years but the house we just visited has already been there 10 years and is still in good shape. She guesses 15 years.

Estimating the price of the house we just visited, she approximates it at 15 to 20 million rupiahs (about 940 € to 1 250 €), which is expensive she says.

Devi's opinion did **not change so much** following the visit but she went from hesitating about considering bamboo for construction to stating that she surely would someday build in bamboo.

She also changed her idea about the **lifespan** of a bamboo house, now thinking it can last 15 years.

4.4.4. IN-DEPTH INTERVIEW OF NGURAH

Ngurah describes how he felt throughout the visit like a kind of nostalgia, bringing him back to his childhood and used to live in a bamboo house. He recalls how Bali, around Ubud, used to be a lot less urbanised and how a lot of farmers had bamboo untreated houses.

According to him, a properly made untreated bamboo house could last about 20 to 25 years. When asked how long the house we visited could last, he answered 20 years as well.

He says he did not change his mind, that living in “this kind of situation”, he would surely like to build with bamboo. Ngurah, however, was interviewed in his home, not so far from the visited place, in the countryside. Thus the researcher asks what difference there is between “this kind of situation” and his. Ngurah then explains how he used to live in Denpasar but now lives between the city and the countryside. As he hosts guests in his house but is quite busy on the side, he does not have much time for cleaning and maintenance. Thus the easy way, from his point of view, is the concrete and tiling materials.

Estimating the price of the house we visited, he says it must cost about 150 million rupiahs (about 9 500 €) to build a house like this one and that the advantages are that it is natural and healthy for the lungs. However, he mentions he dreads insects and termites to destroy such a house.

Ngurah states that **he did not change his mind** about bamboo construction. Nevertheless, when asked about the **lifespan** of a bamboo construction, this time, he gives a slightly different answer than the first time: from 15 to 20 years, he is now saying 20 to 25.

Throughout the commented walks, two out of the four participants mention that this process actually made them **change their mind** about bamboo construction. The two other participants state that their opinion **has not changed**. However, the answers some of the questions already asked in the in-depth interview a priori **slightly vary**.

4.5. EXPERTS IN-DEPTH INTERVIEWS AND CONFERENCE

As these experts are more informed on the matter, this will be a place to gather some additional knowledge on general bamboo construction in Bali. However, it is of course important to keep in mind that the researcher should always make a step back and have a critical opinion on what the interviewees might say.

Nevertheless, some very interesting points of the discussions will be highlighted and used to formulate specific indicators we should not neglect. This will either take the form of direct quotations from the discussion or general ideas that can summarize some of the main thoughts expressed throughout the interviews.

4.5.1. IN-DEPTH INTERVIEW OF CHIKO WIRAHADI PURNAWAN, ARCHITECT

Chiko Wirahadi is a Balinese architect specialized in bamboo construction. He worked for **John Hardy's** company, Indah Bamboo, back in 2005 and describes how that really influenced the way he works now. It got him to work with bamboo and to base his work on an **environmentally friendly approach**.

However, his own house is not made of bamboo. His current house is indeed made of concrete and wood because he designed it 20 years ago when he was still a student. Together with his wife, he chose a neighbourhood in the city, which is pretty dense. As he puts it, "we used traditional standard Balinese materials". Even for an extension to his house, **he still would not use bamboo** "because **it's not [going to] fit** on with the building itself and the durability (...) it would be not matching. Maybe for some decoration like interior" he says.

When asked about what he would think if one of his neighbours was to build in bamboo, he answers that bamboo in his neighbourhood would stand out and be a nice surprise. "As long as the government give their permission" he adds. Here, we take that opportunity to ask if the authorities imposes any restriction, keeping people from building with bamboo. He answered that **the government might even encourage it** as it wants people to use local materials, which bamboo is. However, he still mentions that **extravagant shaped buildings in urban areas might not get approved** if it is too far from the Balinese traditional architecture.

As a young adult, he struggled to manage and pay for his studies and breakthrough in architecture. After working with Indah bamboo, he started, seven years ago, his own architecture studio. He is now a successful and very busy architect and works on big projects such as the Sun Sang Eco Village.

He tells us how he has seen the mindsets evolve. A couple of years ago, people were still hung up on the fear that bamboo might be too **prone to high-maintenance** and too **short-lived**. He also mentions the idea people used to have that bamboo was **unhygienic**, that rats would live there and make people sick. That is, according to him, why people got the idea that bamboo was the **"poor-man's material"**. Nowadays, he

says, as we keep promoting bamboo through hospitality businesses, people are getting curious and the demand for bamboo housing is increasing. **Chiko states that it is an old people mindset to think that bamboo is not suitable for housing.** According to him, that generation is disappearing and with it, the prejudices against bamboo construction. He also insists on the fact that foreigners bringing in different cultures and opinions to Indonesia are helping change the mentalities faster as Indonesian people tend to look up to Americans and Europeans regarding the lifestyles and habits : “If the European and American are using bamboo then ooh, okay, now it becomes fancy”, he says. Bamboo is “**new**” and “**creative**”, and that is what people are now looking for, according to him.

He now uses bamboo in 90% of his projects and aims at a public of **foreigners and locals**. He states that he used to have only commercial projects for the touristic and catering sectors but lately, for the past three years, he has been having more and **more housing projects**.

When dealing with budgeting, he differentiates what he calls “public” buildings (hotels, restaurants, etc.) from the private housing type. For touristic structures, he usually stays around 3 to 4 million rupiahs per square meter (i.e. about 180€ to 250€) whilst for housing it is more about 4 to 5 million (250 to 310€). It depends on the program and details asked for, of course. According to him, given the whole process for treatment of the bamboo and maintenance coming after the construction, **concrete is still cheaper than bamboo whilst bricks are still more expensive.**

Comparing these materials from a **lifespan** point of view, Chiko places bamboo as the less durable material, followed by brick then concrete. Chiko declares the **standards are 15 to 20 years, even when treated.** But then if you maintain the building, he says, the buildings can last way longer. He regrets the current lack of better treatments. He would really like the scientific community to enhance its performances outdoors.

Chiko was also subjected to the photo-elicitation process.



The first one he chooses is because he likes the idea of bringing together various materials and making them work together. Here **adobe**, as it is also **sustainable**, really fits in with his vision of the future of bamboo construction.

He then chooses the two other ones because “this is my dream”, he says. He would like to design **prefabricated houses** to ship all around the world and could then be assembled on site in a week or so. That way, he thinks it could help people in need to have a house quickly, after a disaster. He insists on the fact that Indonesia is frequently shaken by dramatic events. For him, a simple cheap design could be a good start for the government to invest in, in order **to bring help to the population** after these kinds of **catastrophes**.



When asked to formulate keywords reflecting his vision of bamboo construction, Chiko mentions “**local empowerment**”, “**sustainability**” and “**enhanced creativity**”.

The main topics Chiko addresses are the following: the **sustainability** of bamboo construction, the **architectural context** in which a project wants to fit in, the role the **authorities** might play encouraging the use of bamboo, the general mindsets forging a common negative perception of the material being unhygienic and the “**poor man’s material**”, the **lifespan** of a bamboo construction, the **creative innovation** possible with such a material, the increase in demand for **housing projects** lately, the **cost** and finally the possibility to **combine bamboo and other materials** to enhance each other’s virtues.

4.5.2. IN-DEPTH INTERVIEW OF THIERRY CAYOT, BAMBOO STRUCTURAL ENGINEER

Thierry Cayot has founded Asali Bali in 2003. Asali Bali is an engineering company which has been specializing in bamboo construction and is now, since 2012, a staple in large-bamboo-buildings construction.

What brought Thierry to bamboo construction was the urge of finding an **ethical** and **environmentally friendly** business line. He first worked a lot with timber but thought he was harming the forests and had to lead his company to a more conscientious market.

Thierry states that the market he is targeting with Asali Bali is mostly a **high-range tourism** sector. He details it as follows: 40% classy tourism, 20% industrial buildings and 10% residential. The remaining 30% are described as miscellaneous smaller projects. Another fact he mentions is that his customer base is almost entirely comprised of foreigners.

Regarding the **lifespan** of bamboo construction, he qualifies it as depending a lot on various factors. As he says, it can last 5 years if it is not properly constructed. But if it is well designed and built, that the bamboo is treated, it can last a lifetime. He illustrates this with the example of a man, in his wife’s family, who used traditional methods and a smart design protecting bamboo from rain and rot. This house, he says, stayed up longer than 85 years. He goes on by stating that on top of these traditional and smart designs, if you add the technologies and engineering contemporary methods, you might obtain a building that lasts for centuries. Unfortunately, he says, we have not had the time and hindsight to actually prove this yet.

Discussing the **budget** of a regular 30 to 50 square metre house, he announces, all fees included, 1 to 5 million rupiahs per square metre (from about 62€ to 310€).

His personal house is not bamboo made due to some **site constraint**: as he had to build on an inclined land, he was building most of the house in the ground. Thus bamboo would

not have been a suitable and smart choice. However, for the roof, he chose a bamboo framework. He also recalls his previous house: a prefabricated timber house he bought and he personalized with bamboo flooring, wall-cladding, roof and rafters.

When asked about how his neighbours welcomed bamboo construction, he states that his foreign neighbours are optimistic and think it is great whilst the **Balinese neighbours are bewildered**. According to him, **bamboo is not acceptable to the locals** and the hindrances are essentially cultural. Bamboo is considered as the “**poor man’s material**” because people who do not have money to build with timber or brick build with bamboo, and when it is poorly built, neither treated nor well designed, it has a very limited lifespan of 4 to 5 years only. This is bad advertising for the material. Thus the rare Balinese clients Thierry has, he says, are highly educated. He mentions a school director for whom they constructed a 50-metre-long school.

He adds that in the middle Balinese class, for example in his village, people do not understand that bamboo can be used for other uses than furniture, temporary sculptures in temples for the ceremonies etc. When the ceremonies are over, they throw all the bamboo away. **There is no regulations stopping people from building with bamboo, but people do not see that it can be suitable for housing.**

His idea to manage a change in the mindsets was to **promote the material through large, impressive buildings**. Another drawback is the perception people have of its **durability**. People only tend to trust heavy concrete or brick building to last. Thierry hopes that, keeping on showcasing impressive bamboo projects while building an economy on bamboo homestays in his village, he will be able to prove, on the long term, **that bamboo can last** and suit people’s needs.

Furthermore, he explains how Asali Bali now have a **maintenance option** together with the projects they build and a **guarantee** linked to it: one-year warranty to keep the building in good shape, visit twice a year to check on it and the possibility to renew that contract every single year. This way, the company aims to show how a well-maintained building can live up to the long-term expectations.

Thierry, as a French entrepreneur who has been living in Bali for about 20 years, thinks that bamboo is still not yet acceptable for Balinese locals. He mentions that it is a culturally based mindset: people see bamboo as the “**poor man’s material**” and think it will not be able to last at all. Thus right now, the public he targets is mostly **high-range tourists**.

Moreover, he addresses the following matters: the search for sustainability and **ethic** that brought him to bamboo construction, the **lifespan** of a bamboo construction, the **regulations** (not being against bamboo) and the means he sets up in order to try and **improve the perception** Balinese people have of bamboo construction: promoting the material through big buildings and offering a maintenance option to his clients along with a guarantee on the building.

4.5.3. IN-DEPTH INTERVIEW OF PUTRA, OWNER OF A BAMBOO HOUSE

Ketut Putra is a 36-year-old man who works in hospitality. He has a few rooms which he rents for guests. He lives in a bamboo-structure house in Gianyar, close to Ubud.

His property is more of a dense compound. At the front, we find, right after the compound wall surrounding his land, a couple of pavilions he lives in together with his family. The pavilions merge bamboo, steel, concrete, cement plaster and even a little bit of timber. The concrete he uses is essentially for the compound wall.

At the very back of the property, he built a full **bamboo** larger building which is **the guest house**, with the view on the rice fields at the back. He built it in six months and it has been there for three years now. He states that he is the **only one** owning bamboo pavilions in his village.

According to him, Balinese people usually only picture **bamboo as a business**: they might build bamboo houses but not for themselves to live in. They would rather build them to sell to foreign investors. He goes on about the fact that people, over 30 years ago, used to build way more with bamboo. It is still **“cheap”** and **“good-looking”**, he says, but it is a shame that companies are turning it into much of a business, **making the prices go up**. According to him, bamboo is the cheapest amongst wood, brick and concrete. He goes on detailing the prices: for a regular Balinese house, with common materials such as concrete, bricks and timber, it is about 5 million per square metre. When he builds a bamboo house, he only charges 1 million per square meter. **“Borax”** is cheap, bamboo is cheap, he says. It is the big companies that are making bamboo expensive, he says.

Putra then mentions that he actually **self-built** the whole compound he lives in. Now he is trying to make a business out of bamboo as well. Being cheap and **very easy to find in Bali** (he mentions the village of Tabanan, where a lot of farmers have bamboo to sell), bamboo has been the ideal material for him. He got the craftsmanship knowledge from his dad and added the treatment process to the old ways. He treats his bamboo with a **“Borax”** solution.

Telling how he got the will to carry on with bamboo and learned about the **treatment**, he gets talking about the fact that he used to work for **John Hardy** (founder of the Green School and Indah Bamboo), a long time ago. That is, he says, why he knows bamboo is **“very good for making houses”**.

However, the guest-house at the back is still **infested by powder beetles**. The reason for this, says Putra, is that he **did not** quite follow **the correct procedure** of use of the treatment. He was supposed to leave the bamboo soaking for about a month but was in such a hurry that he only left it for two days.

When asked what his neighbours think of his house, he says that they think it is **old news** and just **normal**. Whilst for foreigners, they are usually impressed.

In his opinion, **people look up to concrete luxury villas** and thus want to use concrete as well in their houses. They are not used to bamboo buildings looking nice and fancy. If they are aiming for the **natural look, then they turn to wood**.

Putra insists on the **renewable** characteristic of bamboo compared to wood: for a tree to fully grow and be used for beams, you have to wait a hundred years, he says, whilst with bamboo, in 7 years, it is done.

Putra is the only Balinese man in his neighbourhood owning bamboo buildings. He built his whole compound himself. He chose bamboo because it is **locally available, renewable** and **abundant**. He treated the bamboo but did not follow correctly the procedure and ended up having **powder beetles infesting** his buildings, drilling holes in the poles.

According to him, bamboo is “old news” for Balinese people who would rather use concrete or wood for their own constructions. However, people seem to know there is **a business** to develop there, building in bamboo for **foreigners**.

4.5.4. CONFERENCE BY ELORA HARDY, LEADER OF IBUKU TEAM, BAMBOO DESIGNERS

This section comments a conference given by Elora Hardy, leader of the designing team of Ibuku and daughter of John Hardy, founder of the Green School and Indah Bamboo. However, throughout the speech she gave and through the answers to the audience’s questions, she stated some responses interesting for our problematic.

She has been working with artisans, architects, designers, leading now a team of 130 people. “A whole new industry [is] in motion” she states.

One cannot buy reliably treated bamboo at a hardware store, so they had to harvest trees and process them before even get to building. Thus the logistics linked to bamboo construction are still an issue at this time.

According to her, in bamboo construction, you can find innovative organic shapes leading to beauty. “Maybe beauty is essential, maybe there’s something critical in there.” She says.

While speaking passionately about bamboo, she goes over all sorts of aspects of these types of construction:

- “We’ll design the house very often to fit in these existing contours of the land, no bulldozers, no level. These are the foundations of 6-storey-house. We build light on the land whenever possible, respecting it.”

Elora evokes here the **landform** and the capacity of bamboo construction to **embrace it**.

- “These long legs will flex shift long before they crack under the pressure of any earthquake.”

This statement regarding the behaviour of bamboo structures submitted to an **earthquake** presupposes they would not crack in such a case.

- “These are the kids at Sharma Springs, it is the morning, there is the mist, they feel it on their skin. The light is beginning to play through the space. There's some breeze, there is something about what the air around us can give us if we let it in that can add so much. (...) So it's about moments of light, it's about moments of feeling. Humans and other natural thing, we aren't made of so many right angles and straight lines. (...) It comes down back to the little things: a sense of texture and the energy that you get from encountering textured surfaces. The first step of your day onto soft warm bamboo wood under bare feet.”

Here, Elora Hardy really gets talking about the **sensory** feelings brought by the architecture she defends. The vocabulary she uses is clearly related to the senses: breeze, air, light, texture... It is almost as if we could **feel** the space by listening to her description.

- “We did not discover this plant. (...) But until recently it was almost impossible to reliably protect it from insects. (...) And for that reason, just about everything that was ever built in history from bamboo, just about everything is gone. And that is because unprotected bamboo weathers, untreated bamboo gets eaten to dust.”

This time she mentions topics often addressed in this master thesis: vulnerability to **insects**, **weathered** bamboo, **treatment**, lack of **historical buildings**.

- “But more importantly, that is why most people in the world, especially in tropical regions where bamboo grows, feel that you couldn't be poor enough or ignorant enough to actually consider living in a bamboo house.”

Here again, bamboo is described as “**the poor man's material**”.

- “Beyond beautiful fanciful structures, what we are really going to need to do is to house millions of people and this is not the way to do that, I'm not pretending that it is”,

Elora raises here the **housing need** problematic due to population increase.

- “We are going to have to do it with materials that won't run out on us”,

Evoking the need for an environmentally friendly renewable material, **abundant** and **fast-growing**.

- “You can think about it as being pretty much equivalent to a wooden house, designed properly to begin with to protect it from the insects and then it's designed smartly to protect it from the UV and that the engineering is all done well, you can expect a properly built bamboo house to last as long as a properly

built wooden house. And there are wooden houses that are hundreds of years. (...) You also ask about maintenance: the maintenance is also quite similar to wood. Every few years you need to recoat it.”

Elora is here speaking about the **lifespan** of bamboo and the fact that it has not had yet the chance to prove itself durable since we developed better **treatment** techniques and wrote about the smart **design** to keep bamboo unharmed.

- “[Bamboo] is definitely being accepted as a business opportunity (...) They don't see it like people building their homes and villages out of it again, they are still remembering their grandmother's home that wasn't able to last as long because it wasn't properly treated.”

The topic was here directly aiming at the **acceptability** of bamboo construction for the Balinese's housing, mentioning that people do not accept bamboo, that it is pictured in people's minds as **the material of the past**, and nowadays rather see it as a business opportunity targeting **foreigners**.

- “We are working very much outside of any system of regulations, (..) when we have an earthquake, there will be so much tragedy, because there hasn't been a way of, from what I understand happens in certain parts of the world, of (...) [requiring] builders to have smart choices and integrity around the material that they're using and the structural techniques.”

This comment concerns the authorities and **lack of regulations** she regrets.

- “It is more expensive [than other materials]. We are able to usually charge something similar to what it would be in another material (...) because the raw material is very affordable. But it has to go through so many hands in order to be properly treated and dried and prepared and crafted that by the end of it, (...) our clients have embraced it as a luxury product. (...) The price is actually higher.”

Regarding the **costs**, Elora stipulates that the **complexity of the procedure** used at the Ibuku studio – from the farmers harvesting the bamboo, through the treatment process, to the workman mounting the building, along with the design and engineering preceding and the follow-up of the operations – makes their building **expensive**. They charge prices similar to other luxurious villas.

In the end, Elora Hardy addressed topics that had already been of interest in this master thesis throughout her conference, **enriching the diversity of opinions collected** on the matter.

CHAPTER V – DISCUSSIONS

We first recall the main questions orienting the research:

- Why is bamboo not used as a common construction material for housing by the local population in Bali?
- How is bamboo perceived by local people in Bali?
- Is it acceptable for housing from the local people's point of view?
- What criteria could be used as qualitative indicators to evaluate perception of bamboo housing?

In this chapter, we **gather information**, crossing the various tracks of answers collected in the results. The purpose is also to **formulate qualitative indicators** for bamboo housing and discuss them regarding the state-of-the-art, **interpreting** and criticising them. We recall that, by qualitative indicator, we mean a factor or variable used in establishing guidelines for observation and evaluation. In this case, it points to the evaluation of the perception of bamboo construction, particularly residential construction (Church & Rogers, 2006).

The research inevitably reached some **biases and limits**, from the choice of the methods used to the actual conduct of the study and impact of unforeseeable factors throughout the process. These are also discussed in this chapter.

Furthermore, we open the discussion for further **research opportunities** that this study suggests.

Finally, we develop the outcome of the **International Bamboo Construction Competition (IBCC)**, explaining how this master thesis influenced it. We also give a short brief of the on-site construction process and of the finished product.

5.1. INTERPRETATION OF THE RESULTS

The survey helps identifying the most common construction materials used in Bali and some of the comments made by Thierry Cayot, Elora Hardy and Ketut Putra confirm the fact that bamboo is not much used by Balinese people for their own houses.

When trying to dig further and understand why that is, the topics suggested in the state-of-the-art (Sections 2.6.2. & 2.6.3.) are the **socio-cultural context**, along with the **perception** that the cultural context gives of the material. Furthermore, the perception of its **cost** and **lifespan**, its perceived **safety** and **sustainability**, its **local availability** as well as the **sensory perception** are also addressed. These topics can also be considered as indicators of perception and acceptability of the material. Furthermore, **topics spontaneously addressed by the participants** are added to these indicators.

SOCIOCULTURAL CONTEXT

Bali has been described before as a **favourable environment** for bamboo construction. Thanks to figures such as Linda Garland and John Hardy, the promotion of bamboo as a construction material has gained momentum, through remarkable buildings around Bali (Koskoff, 2008).

Indeed, the experts' interviews showed that **John Hardy** was an **inspirational figure** common to both Putra, the Balinese bamboo house owner and Chiko, the bamboo architect. If some of them are already convinced by the material, most people answering the questionnaire do not consider bamboo, at least at first, for a new construction. The same goes for the interviewees. Ade qualifies it, *a priori*, of a material **only old people** from the countryside would use. Even Chiko, an architect who has been working in bamboo construction for years, thinks he would not use bamboo for his own house. The questionnaire shows that it does **not seem like there is an influence of the age** nor originating district on this matter.

The **legal framework** could have been an actual context restraint. However, throughout the survey and all interviews, no one mentions any regulations upon bamboo construction. Some of the interviewees, for instance Ngurah and Chiko even mention that the government encourages people to use natural materials available locally, including bamboo. Elora mentions the lack of any proper regulation in construction in Bali.

Nevertheless, Chiko mentions the fact that one might have troubles getting a building permit if the bamboo building they plan is too extravagant and does **not fit in the urban context**. This brings us to the next focus of interest here: the suitability of the building within a built context. The answers to the questionnaire mention that bamboo is unsuitable for cities, and thus rather adapted for rural environments. This point of view is shared by some of the interviewees, especially Ade and Ngurah. However, Putra lives in a dense lot in Ubud and defends the possibility of combining materials with bamboo to fit in. In the state-of-the-art, we can see an example of how contemporary bamboo architecture can still adhere and fit in a traditional Balinese compound (Figure 35). Defining if and how bamboo construction and possible typologies could suit other Balinese urban typologies could constitute an interesting research topic.

Thierry goes further, stating that bamboo is currently **not acceptable for Balinese** people as it is considered as "the poor man's material". Elora also sides with this opinion saying "most people in the world, especially in tropical regions where bamboo grows, feel that you couldn't be poor enough or ignorant enough to actually consider living in a bamboo house" (Transcript H). This was already stated in literature, described by Nurdiah's studies for instance (2016). Elora gives a hint of answer to why that is: in her opinion, people do not know about treatment methods or do not trust these methods to make a house really last. We will come back on treatment questions with the perception of the lifespan of the material further in this chapter. The line is also thin

between this being a matter of cost or of social acceptability. We will come back to it in the next section.

Thus, the sociocultural context indeed **influences** one's **perception *a priori*** of bamboo construction. However, as seen throughout this experiment, especially with Ade, the **commented walk** method and meeting with the **current owner** of a bamboo project can drastically change someone's opinion on the matter. Thus **this procedure** may be interesting to implement in architecture during the pre-project phase, thus collecting an *in situ* opinion from the user. This could open new realms for creativity in favour of **renewal of typologies** as this method could offset the innovation curbs.

PERCEIVED COSTS OF A BAMBOO BUILDING

As hypothesized earlier in this master thesis, there is a paradox in the perception of the bamboo being “the poor man's material” by some, while also being a luxurious material to others (Nurdiah, 2016). This bipolarity has been confirmed in the results: half the people in the questionnaire and the in-depth interview *a priori* consider bamboo as a really cheap material for instance, while 9% of the participants in the questionnaire still think it is really expensive, and so does Devi, a 22-year-old interviewee. Even the experts are divided on the subject: Elora, lead architect of Ibuku studio, and Thierry, bamboo structural engineer, present it as a luxury product while Putra defends it as very cheap and accessible. Ngurah, a 65 year-old retired man, and Chiko have a more balanced point of view. Ngurah states that the material is cheap but the maintenance of such a building is expensive. Chiko qualifies it as affordable, just as 15% of the questionnaire participants. The questionnaire showed this perception does not seem to depend on the age nor district but might be linked to the level of education of the person. To be confirmed, this matter should be investigated deeper, with a much wider sample.

To illustrate this problematic, for an 80 square metre house, various interviewees give very different prices (Table 10). Of course, this quantification varies according to the social class of the individuals and to their experience in the field.

| According to | Ayu | Ade | Devi | Ngurah | Chiko | Thierry | Putra |
|--|---------------|------------|-----------------|--------------|----------------------|---------------------|--------------|
| Price /m ² (IDR) (approx.) | 2.5 M | n.m. | n.m. | n.m. | 4-5 M | 1-5 M | 1 M |
| Price /m ² (approx.) (EUR) | <i>150</i> | | | | <i>250-310</i> | <i>62-310</i> | <i>62</i> |
| Price for an 80 m ² house (IDR) (approx.) | <i>200 M</i> | 15 M | 15-20 M | 150 M | <i>320-400 M</i> | <i>80-400 M</i> | <i>80 M</i> |
| Price for an 80 m ² house (EUR) (approx.) | <i>12 500</i> | <i>950</i> | <i>950-1250</i> | <i>9 500</i> | <i>20 000-25 000</i> | <i>5 000-25 000</i> | <i>5 000</i> |

TABLE 10 – PERCEPTION OF COST OF AN 80M² BAMBOO HOUSE

N.M. : NOT MENTIONED

ITALIC : CALCULATED FROM THE GIVEN DATA

APPROX.: APPROXIMATE PRICE

Ade and Devi are young women and do not really have experience in construction. That explains why the numbers given are so low.

Elora and Thierry, being heads of big companies, mostly building luxury villas, hotels and restaurants, could not sustain their businesses building small low-cost housing projects. Putra is not very rigorous in his treatment process, perhaps saving money by making everything himself but not perfecting it enough to avoid further troubles like insect infection of his bamboo buildings.

There must be a balance to find and perhaps cost efficiencies to develop in order to promote bamboo housing with prototypes such as H&P Architect's Bamboo Home in Vietnam (see §2.1.2.).

PERCEIVED LIFESPAN OF A BAMBOO BUILDING

The lifespan of bamboo is probably the main concern expressed by interviewed people regarding bamboo construction. "Short-lived" and synonyms are mentioned 16 times throughout the questionnaire, particularly when it comes to the disadvantages of bamboo construction. We can also find the word "Termites" 15 times as a sign of the concern people have of insect attacks. We recall that only untreated bamboo is subjected to these attacks.

Ayu, Ade and Ngurah specifically mention concerns regarding the short lifespan of bamboo construction, while Devi still says bamboo only lasts 5 to 10 years. Ngurah once again clarifies his comment specifying that his concerns are about untreated bamboo as, according to him, Balinese people do not use chemicals on their bamboo.

The questionnaire also highlights the fact that people do not trust any bamboo construction to last more than 25 years, as 96% of the people surveyed answered so. While Chiko says that it is an old people's mindset to think that bamboo does not last long enough to be suitable for housing, the questionnaire showed that it does not seem to be age-related. However, we notice that the lifespan perception increases when the participant knows a bamboo house owner.

Elora's earlier comment precisely aims at this matter: people might not know about the treatments or might not trust theses. Of course, the actual lifespan of bamboo construction varies a lot with parameters such as the details of the design, whether it is inside or outside, in contact or not with rain, or with the ground. We recall Table 1 (Suggested approximate length of time before bamboo will need to be replaced) (Kaminski et al., 2016). It states that the lifespan of bamboo goes from maximum 4 years to more than 30 years in the same conditions³ whether it is left unprotected or if it is treated with fixed preservatives (see §2.3.).

According to the experts interviewed in this study, a well-made bamboo construction could last a lifetime (Thierry, see §4.5.2.) or even hundreds of years (Elora, see §4.5.4).

³ Exterior protected from the rain, which is common in well-designed bamboo buildings in Bali.

PERCEIVED SAFETY

As mentioned in Section 2.4., we have reliable data to conclude positively about the fact that treated bamboo is technically suitable for housing. However, safety is also a concern that has been raised a lot throughout this study.

“Weak” is also mentioned 16 times throughout the questionnaire, particularly often in regard of the disadvantages of bamboo construction. It is also a topic worrying Ade, especially during the commented walk. She wondered a lot if the material was strong enough to bear her, shifting from insecure about the reliability of bamboo to trusting it by the end of the experiment, saying it is strong enough for her and that she feels comfortable. Thus this concerns mainly touches people *a priori*.

Nevertheless, the topic of “earthquake-resistance” (as participants say) comes up quite a few times as well: it is evoked 7 times in the advantages of bamboo construction and highlighted by Ayu as well. Elora mentions, regarding the behaviour of bamboo structures submitted to earthquakes, that bamboo structures would not crack but rather bend.

A concern that also emerged a couple of times in the questionnaire is the **flammability** of bamboo construction. This matter is poorly documented and would deserve to be studied in depth. All we can say is that, for now, there are no specific products that have been developed exclusively for bamboo at least that we know of. Thus once again, the products used on bamboo to reduce its flammability are originally developed for timber.

LOCAL AVAILABILITY

Another subject raised in the state-of-the-art on the appropriateness of bamboo construction is the local availability of bamboo species suitable for construction. We mentioned that in Bali, bamboo Petung is abundant.

This matter is mentioned 12 times in the questionnaires and highlighted as a great advantage of bamboo construction, for instance by Ade, Thierry, Putra and Chiko in the interviews.

This might be an interesting factor to consider urgently, given the increase of population needing shelter, and the requirement to face this problematic sustainably, protecting the environment. As Elora mentions in her speech, we need an abundant and fast-growing material that will not run out.

PERCEIVED SUSTAINABILITY

This brings us to sustainability of such a fast-growing abundant material. We still do not know if this factor is decisive for people to actually turn to bamboo for construction, but it is a matter that is slowly reaching people’s conscience. For example, 8 participants in the survey raise up that topic as advantages of bamboo construction. Ade and Ayu also insist on it in their respective interviews. Ngurah briefly mentions it as well. Chiko and Thierry state that sustainability and ethics is what really brought them to work almost exclusively with bamboo.

SENSORY PERCEPTIONS IN BAMBOO SPACES

The sensory perception is mainly aimed at in the commented walk process. This method was exclusively chosen to make that aspect emerge. However, it is not the only method which brought a couple of sensory factors up.

Indeed, in the survey questionnaire, a few spontaneous participants mentioned the following terms (or synonyms): Smelly, Noisy, Dusty, Uneven, Fresh, Attractive texture/Smooth. Perhaps these are mentioned given the personal experience of these people with bamboo houses.

While the smell can refer to an unprotected bamboo rotting and the dust can come from untreated bamboo getting eaten by insects, the first three adjectives are not flattering for bamboo construction, expressing an unpleasant sensory perception of bamboo space. Uneven is more of a descriptive observation of a surface. It is not clear, though, if that is really problematic but at least, it has been noticed.

Furthermore, the adjectives “fresh” for thermal comfort and “smooth” regarding the texture point at characteristics of a bamboo space that suited the users.

Regarding the commented walks, some of the same topics were discussed. For instance, Ayu complimented the freshness of the air circulation in the spaces while still keeping the noises and smells out. Devi, Ngurah and Ade also mention the freshness of the spaces visited although it was very hot outside that day.

Devi and Ade both comment the texture of the structures. Devi particularly stipulates that one of the two buildings is not smooth enough while the other is more appropriate for her. A smooth finish should therefore be a major concern for bamboo building dedicated for housing.

In addition to these, the brightness of space is a concern the participants had throughout the commented walks. Ayu, in particular, insisted on the need for large apertures. She was satisfied by some of them, but in other rooms, she complained about too limited light. However, the fact she mentioned herself being satisfied in some of the bamboo spaces proves that bamboo can indeed be suitable for bright spaces and wide apertures.

In Elora Hardy’s speech, some of these sensory factors are also mentioned in a description she makes of experiencing bamboo space: she talks about a breeze, the air, light in such a natural space, the texture of bamboo, under one’s feet with bamboo flooring for instance. For her, the unevenness of bamboo is precious, complicated to deal with as an architect, but really essential to bamboo spaces, endowing them with a natural quality. The word “natural” is in fact also a common theme brought up in the questionnaire (18 times, often in the advantages of bamboo construction) and throughout all of the interviews.

OTHER INDICATORS EMERGING

Other topics, such as air-tightness, flammability, maintenance etc., were brought up throughout this study.

Regarding **airtightness**, as mentioned earlier, a light airflow could be felt during the visit. In the survey, someone mentions “Porous” as a keyword to describe bamboo. Described by most participants to the commented walks like pleasant, bringing in fresh air, Ngurah also mentions that it was critical in his opinion. The lack of airtightness lets the dust and insects in, which is not something one would like to deal with on the long term in the house. Moreover, Ade in the interview mentioned the importance of airtightness for urban context where people, in tropical climates, sometimes have a need for air-conditioning.

Elora brings an element of response to this problematic in her talk, mentioning that it is in fact possible to have an airtight building in bamboo. However, she does not mention the price difference of such an improvement. She also regrets the fact that people are getting more and more used to being in control of their environment. Surely, it can be convenient and sometimes even necessary in some cases but she defends the fact that letting go with the control allows people to really experience the present moment and **connect more with nature**. Connecting with nature is also a matter really dear to Ayu, as she puts it in her interviews.

Creativity, beauty and **originality** or synonyms are also brought up a lot regarding bamboo throughout the questionnaire. “Unique” is mentioned 23 times, making it the second most written word in the survey results. “Cool” is mentioned 14 times and the same goes for “Beautiful” while “Artistic” is mentioned 10 times. Some other words still touching upon the same idea, such as “Inspiring”, are also mentioned. As Elora Hardy puts it: “Maybe beauty is essential, maybe there’s something critical in there.” (see Transcript H)

These themes are also brought up in every single *a priori* interview of the small sample of varied profiles. Chiko defends it as a real hobbyhorse to promote bamboo housing: Bamboo is “new” and “creative”, and that is what people are now looking for, he says. He also mentions that lately, he has seen the interest in bamboo as a housing material increasing. According to him, it is the material of the future and it is slowly getting there.

One of the drawbacks of bamboo housing mentioned widely in the survey and interviews is the **maintenance** that the material requires. Evoked 9 times in the questionnaire, particularly worrying Ayu and Ngurah, maintenance seems like a touchy topic. As Chiko and Thierry put it, maintenance is essential to keep a bamboo building in good shape. Elora compares the maintenance process of a bamboo house as being very similar to the maintenance of a wooden house. These interventions become the costs that make bamboo building unaffordable according to Ngurah. The bamboo component that really brings the maintenance costs up is the alang-alang roofing.

There might be here a real cost efficiency to develop in order to lead to an improvement in the suitability of bamboo construction for low-cost housing. Thierry's company, Asali Bali, insist on maintenance as being crucial to ensure a lifelong duration of bamboo building. Thus Thierry currently offers his clients a maintenance contract together with a guaranty on the bamboo buildings.

Maintenance of a bamboo house can either regard taking care of the materials composing the building or cleaning the building. As we have seen earlier, airtightness is a key to reduce this second type of maintenance. However, building an airtight bamboo house is possible but rather expensive. Thus this opens the discussion on whether airtightness is really necessary in these regions. If so, cost efficiencies of bamboo airtight volumes should be rethought.

Self-building seems like a reasonable way of lowering the costs of bamboo construction. As mentioned before, guides have been lately published promoting bamboo self-construction (see §2.1.). The survey brought up 3% of participants noticing that bamboo is easy to build with. However, the example of Putra's house being infested with insects proves that, in order for a bamboo house to last, professional skills are still necessary.

This might be the **crux** of the reason why bamboo is nowadays still a **luxury material**. Without a real **cost efficiency** improvement from the bamboo craftsmanship sector, durable bamboo is unaffordable. And without the skills, one has to observe that cheap bamboo does not last.

5.2. BIASES AND LIMITS

Throughout this master thesis and the experiments conducted in this context, we notice biases that may affect the result to a bigger or lesser extent.

A total of 57 people answered the questionnaire, and among them, 54 are Balinese. Such a small sample cannot reliably represent the whole Balinese population. Furthermore, the population reached by this study is undeniably biased by the locations where the paper questionnaires were passed out.

Another bias is introduced in the study by the multiple changes of languages of the questions and answers. The questions were first written in English by the researcher, translated to Indonesian by a colleague and read over by another Indonesian person. However, not being fluent in Indonesian, the researcher loses the grip on the questions' structure. Thus, this might lead to methodology biases in the questions (Lugen, n.d.). When translating the answers back to English, the translation was also performed by a non-professional translator. Thus, as a translation is also submitted a little to the translator's subjectivity, some of the subtleties of the Indonesian phrasing may have gone astray along the way.

During the in-depth interviews of the experts, their answers are of course influenced by their life experience. They might also describe the real situation in rather flattering terms as they are showcasing their own businesses. Therefore, we must keep a critical view on the information they give.

In the in-depths interviews of the small sample, particularly with Ayu, Devi and Ngurah, we encounter a strong language barrier as they might not know how to express certain opinions in English. Furthermore, some of the questions asked might introduce a positive bias in the way that they are asked: it is easier to answer positively to a question without explaining why they would think this or that, even more so if they have trouble with the language. However, the interviewer should always try to ask again the same question, reformulating it in order to check if the interviewee really got the question and give them the opportunity to take their time to express their thoughts.

Another bias that might influence the results of these interviews is the fact that the participants want to answer “correctly” the questions, thinking there is an actual correct answer that the researcher is expecting, leading them to answer the question with less honesty.

The commented walk process was, as we mentioned, disrupted by the presence of the owner. He was not supposed to be there according to the established procedure, but due to unpredictable circumstances, he was. This may have influenced a lot the comments throughout the commented walks to avoid offending him. However, it leads to rich conversations during the visits between the owner and the participants, bringing up more topics of interest.

It should be noted that the researcher’s field of expertise is not sociology. This is, after all, an engineering and architecture master thesis. Thus the experiments were conducted by a researcher who is not particularly trained to interview people.

The final indicators established are still only indicators after all. Indicators are imperfect, they vary in validity and reliability depending on the population studied. They also vary in time. Thus they are inevitably approximations (Patton, 1996).

In the end, the list of indicators is not exhaustive. The sensory perception, for instance, is directly related to the perceptions that have been made with regard to the specific site and to the limited number of users involved. These sensitive criteria can be the baseline for qualitative indicators for bamboo housing, broadening the criteria collected by other means, in this case the survey and in-depth interviews. However, another experiment conducted on another site could lead to different indicators.

5.3. RESEARCH OPPORTUNITIES

Here, the problematic is focused on the current perception of the material. Perception evolution management have not been addressed in this master thesis. However, these changes would be interesting to dig into.

It would also be interesting to pursue this study with a larger number of users. Furthermore, in order to understand better the phenomena evoked throughout the commented walk, it would be interesting to compare these with an analysis of the space designed. This would allow to quantify the characteristics of the studied bamboo spaces. In order to do so, a complete scientific analysis of theses spaces would include measurements of brightness, soundscapes, etc. Such a study would require further means and a larger research framework. Nevertheless, this would be a nice dimension to explore.

Moreover, we have mentioned how bamboo homes imitate some of the traditional Balinese pavilions. However, in big cities in Denpasar and Gianyar districts, traditional Balinese compounds are not necessarily the norm anymore. Thus defining if bamboo could fit in Balinese urban typologies would also constitute a whole research topic, starting with the analyse of the current urban typologies. Bamboo could also be a part of an architectural movement renewing urban typologies. This could favour as well a renewal in the perception and uses of homes.

We have also seen in section 2.4.8. that limited research has been conducted on creep of bamboo and that more studies on that matter would be welcome. We also mentioned in the same section that, at the moment, no fire treatment has been tested for treated raw bamboo that we know of. Thus, we also suggest it as another interesting area of research.

5.4. IBCC OUTCOME

The IBCC-2019 was the International Bamboo Construction Competition this year with “blossom” as the guiding theme.

The Bale Dangin pavilion - a kind of kiosk, sitting room or siesta platform used by Balinese people in miscellaneous ways - had been mentioned by Ade and Devi as a building they would like to have made of bamboo (see §4.2.). Thus this kind of multifunctional pavilion was the perfect inspiration for the contest’s project. Together with the lotus flower, they were the base of the design intentions.

Then, the curved surfaces, appreciated by the participants in the photo-elicitations (also in §4.2.), inspired the shape of the pavilion.

Throughout the design of this pavilion, I was particularly attentive to the indicators that emerge from this master thesis’ research. The bamboo is treated, kept as raw as possible to keep the possibility for the user to connect with nature. We were particularly careful on-site during the construction to ensure freshness in the pavilion, smoothness of the bamboo and brightness of the space.

An aperture at the top of the structure creates the airflow providing freshness. The moso bamboo was carefully buffed to give a really smooth texture to the poles. The petal seats are kept raw and uneven to properly feel the bamboo relief. Finally, the light flows in easily thanks to the opening petals and the translucent lining.

In July 2019, we were amongst the three final laureates selected for the final round in Beijing at the International Horticultural Exhibition. Our team went to China to build a 1:1 model of the project, which was awarded the First Prize (Xue, 2019).



FIGURE 57 - HOUSE LOTI FOR THE IBCC 2019, PERSONAL COLLECTION OF PHOTOGRAPHS

The multifunctional pavilion has a small ramp to enter the first storey, about 50 cm above the ground. The second floor is only accessible using a bamboo ladder which can be hung upon a bamboo beam.

The structure is as polyvalent and versatile as possible. The upper level can be used as a small resting space, for storage or even as a small office. The ground first floor might just be used for the same purposes, but it could also be used as a bar, for educational purposes or as an art gallery. On top of the structure, a polycarbonate leaf shaped panel elevates from the top circular opening to prevent the rain from getting into the pavilion whilst still letting light in and air out from the top.

The structural elements were meant to be covered with a two layers' skin made, from inside to outside, of bamboo woven panels and translucent tent fabric. The fabric should have been 100% cotton, bio-epoxy covered and naturally dyed with yellow on top, white (natural cotton white) for most of it and pinkish bits on the petal contours, using avocado for the pink and jackfruit and turmeric for yellow. These colours were chosen to recall loti flowers. Yet, because of availability issues, the contractor had to replace the cotton tent fabric with polycarbonate panels. Whilst we did lose the shading effect of the tent fabric, the transparent panels offer the opportunity to have a panoramic view from the top of the structure.

The structure is made of six frames, which are prefabricated and assembled together on site into a hexagonal shaped plan. These then hold the primary floors structure and end cap on top. Finally, the final flooring is affixed. This method allows another requirement to be fulfilled, the fact that the on-site construction has to take no more than 24 hours.

Each frame has two pivoting petals: one small pivoting into a seat and another large one on top pivoting into a sunshade. The seat piece petal has a pivoting leg which can insert into a small metallic notch on the ground. The sunshades petals are connected with a cable to a pulley system enabling the user to turn a hand crank opening the petals.

The model was first made with Rhino 3D + Grasshopper then transferred to ROBOT Autodesk for the analysis. The maximal displacement at the top of the structure is equal to 5.9cm. This displacement, corresponding to $H/93$, is acceptable for a temporary building.

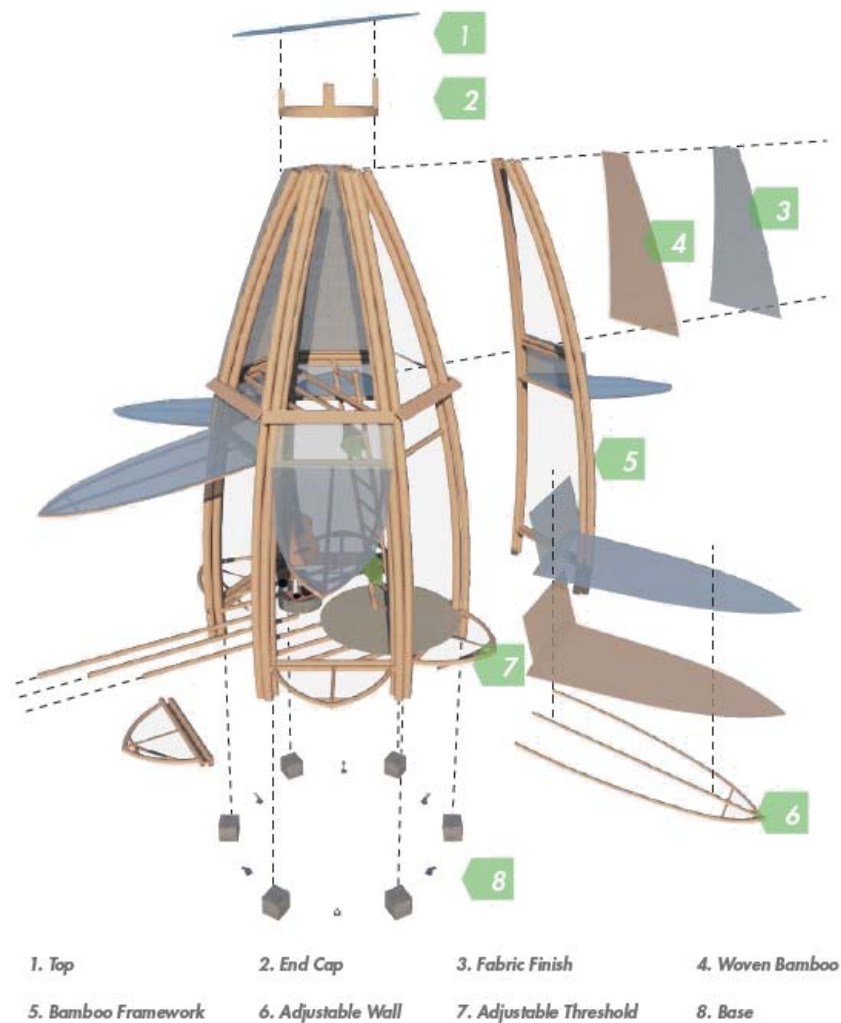


FIGURE 58 - HOUSE LOTI, EXPLODED DIAGRAM OF COMPOSITION

Mounting and assembling the pavilion on-site took only two supervisors, three workers and less than 22 hours. We then presented the pavilion to a jury, among which we had the chance to meet, for example, Mauricio Cardenas, CEO of Mauricio Cardenas Studio and architect of the INBAR Pavilion and Cui Kai, the main architect of China Architecture Design & Research Group. After the jury's deliberation, we were awarded the first price of the competition. The structure is currently standing at the International Horticultural Exhibition in China, right next to the INBAR “Bamboo Eye” Pavilion until October 10, 2019 (Xue, 2019).



FIGURE 59 - MOUNTING THE HOUSE LOTI PAVILION ON-SITE, PERSONAL COLLECTION OF PHOTOGRAPHS

CHAPTER VI – CONCLUSIONS

In this master thesis, the issue at stake was to **evaluate the perception** Balinese people have of bamboo construction, particularly for housing. In order to do so, we had to establish **qualitative indicators** as guidelines. Then we discussed them, crossing the data obtained through the various experiments conducted. The methods we chose to learn about the Balinese people's perception were the questionnaire survey, the in-depth interview and the commented walk.

The first one, the 24-question-**survey**, was aiming at a large public. It got 57 participants. It collected data on the **common materials** used in Bali, the ideal material participants would choose for a new building and then evaluated the **perception of bamboo** under various angles.

The second method, the **in-depth interview**, targeted two small samples: 3 expert actors in bamboo construction, each one in their own way, and a sample of 4 various chosen profiles.

The experts sample included a bamboo **structural engineer**, a bamboo **architect** and a bamboo-house **owner**. Each of them brought an overview of their domain regarding bamboo. This work also benefited from another bamboo expert's opinion: Elora Hardy, who agreed that we include one of her **speeches** in this master thesis. Thus, she broadened the results with her experience.

The last method, the **commented walk**, is an ethnological approach consisting of collecting the users' on-site comments. It aims to capture aspects of the sensory perception. It was conducted with the same sample of 4 chosen participants as the in-depth interview *a priori*. This method was implemented in order to retrieve some sensory perception indicators from the participants.

The following indicators came out of these experiments:

- **Sociocultural context:** whilst Bali really seems to be an appropriate place for bamboo construction to expand, the people still seem to have a bad image of the material and *a priori* do not consider it as suitable for housing;
- **Perceived costs of a bamboo building:** while most people consider bamboo as really cheap, perhaps as it is historically seen as “the poor man's material”, others see it as luxurious and expensive. To overcome this bipolarity, a balance of cost efficiencies must be found;
- **Perceived lifespan of a bamboo building:** this study showed that most people perceive bamboo as very short-lived. Perhaps this is due to the lack of information on bamboo treatment, which is not well-known. However, under the right conditions, treated bamboo can multiply by at least 7 its durability;
- **Perceived safety and flammability of a bamboo building:** the concern for the stability of bamboo structures was brought up a couple of times, as for the

concern about bamboo being flammable. There is not much we can say about flammability. However, regarding safety, a properly designed bamboo structure is just as safe as a wooden house. Paradoxically, people tend to trust bamboo more than other materials in case of earthquakes;

- **Local availability of the material:** in Bali, local availability is in favour of the use of the material. The use of bamboo would promote local craftsmanship skills. This aspect is perceived by some of the participants in this study as an incentive to use bamboo as a construction material;
- **Perceived sustainability of the material:** although this characteristic of bamboo construction is often mentioned as a quality of bamboo construction, it does not seem decisive in the users' choices of construction material. Perhaps further governmental actions promoting bamboo could support its development as a construction material;
- **Sensory perception in bamboo spaces:** sensory factors showed themselves relevant in the participants' *in situ* perceptions. These indicators can potentially forge one's opinion on these types of constructions. Thus, the design of a bamboo project should bring particular attention to sensitive details such as textures, light, airflows, sounds and smells. In this case, the collected comments helped design a prize winning project for the International Bamboo Construction Competition 2019;
- **Maintenance of bamboo buildings & lack of airtightness:** the maintenance of a bamboo house is a concern most of the participants had. Maintenance can either regard cleaning the building or taking care of the materials composing the building. Airtightness is a key to reduce the first type of maintenance. However, building an airtight bamboo house is possible but rather expensive. Thus this opens the discussion on whether airtightness is really necessary in these regions. If so, cost efficiencies of bamboo airtight volumes should be rethought. Regarding the maintenance of the material, treating the bamboo with boric solutions, for instance, diminishes drastically the necessary maintenance of a bamboo house. Nevertheless, the house still needs to be taken care of, from time to time, but just as much as any kind of house. The bamboo component that really brings the maintenance costs particularly high is the alang-alang roofing;
- **Creativity, beauty and originality brought by the use of bamboo:** these aspects are widely highlighted throughout the survey and interviews. For some of them, innovating and promoting beauty and creative typologies is the way to put on the map bamboo as a construction material for housing.

This master thesis could be used as a ground of reflexion for architects or administration members wishing to support bamboo projects in tropical regions.

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APPENDICES

A. SURVEY FORM – ENGLISH

Survey on construction preferences

<https://docs.google.com/forms/d/1waTHKB6MWlPomhaqb3G-DXy0S-...>

Survey on construction preferences

This survey takes place as part of a research for a masters thesis in engineering and architecture. We aim to study construction practices in subtropical regions, especially Bali, Indonesia.

To begin with, we would like to know a little bit about you.
Do not worry, we assure you this data will only help us in the context of a university research program.

*Obligatoire

1. I am ... *

Une seule réponse possible.

- ☐ less than 15 years old
- ☐ between 15 and 30 years old
- ☐ between 31 and 50 years old
- ☐ between 51 and 70 years old
- ☐ more than 71 years old

2. Would you mind giving your exact age below?

3. I work... (please write your field of profession or main occupation below) *

4. I live... *

Une seule réponse possible.

- ☐ alone
- ☐ with my partner
- ☐ with friends/ roommates
- ☐ with my family

5. Please enter how many you are at home : *

6. I live ... **Une seule réponse possible.*

- ☐ in Bali
- ☐ on another Indonesian island
- ☐ in another part of Asia
- ☐ Europe *Après avoir répondu à la dernière question de cette section, passez à "Thank you!".*
- ☐ Autre : _____

7. I come from ... **Une seule réponse possible.*

- ☐ in Bali
- ☐ on another Indonesian island
- ☐ in another part of Asia
- ☐ Europe *Passez à "Thank you!".*
- ☐ Autre : _____

Now, could you tell us more about your home?
Once again, this informations will only be used for research purposes!

8. If you live in Bali, could you tell us where? **Une seule réponse possible.*

- ☐ I don't live in Bali
- ☐ Denpasar
- ☐ Tabanan
- ☐ Klungkung
- ☐ Karangasem
- ☐ Jembrana
- ☐ Gianyar
- ☐ Buleleng
- ☐ Bangli
- ☐ Badung

9. Conveniences you have at home :*Plusieurs réponses possibles.*

- ☐ a kitchen (peacock)
- ☐ an indoor bathroom
- ☐ an outdoor bathroom
- ☐ a north pavilion (meten/bale naja)
- ☐ a rice attic (lumbung/fineng)
- ☐ a ceremonial pavilion (balé dangin)
- ☐ a guest-house or a west Pavilion (balé dauh/balé tiang sanga)
- ☐ a South pavilion (bale sakenam)
- ☐ Autre : _____

10. The largest part of my home is made of... **Plusieurs réponses possibles.*

- ☐ Bricks
- ☐ Concrete
- ☐ Timber/ wood
- ☐ Bamboo
- ☐ Mud/ cob/ adobe
- ☐ Steel
- ☐ Autre : _____

11. In my neighbourhood, most houses are made of... **Plusieurs réponses possibles.*

- ☐ Bricks
- ☐ Concrete
- ☐ Timber/ wood
- ☐ Bamboo
- ☐ Mud/ cob/ adobe
- ☐ Steel
- ☐ Autre : _____

12. **If you were to build a new construction at home without any kind of restriction (in terms of budget or regulations), which materials would you choose? ***

Plusieurs réponses possibles.

- ☐ Bricks
☐ Concrete
☐ Timber/ wood
☐ Bamboo
☐ Mud/ cob/ adobe
☐ Steel
☐ Autre : _____

Now, we would like to know what you think of bamboo-made houses.

13. **Name the first 3 words that come to your mind referring to bamboo: ***

14. **If you had to build an extension to your house, would you like it to be made of bamboo? ***

Une seule réponse possible.

- ☐ Yes
☐ No
☐ I don't know
☐ Yes, at one condition (please describe the condition below)
☐ Autre : _____

15. **Describe the condition:**

16. **If you wouldn't have your extension built in bamboo, explain why:**

17. If you would, which part(s) of your home would it be? **Plusieurs réponses possibles.*

- ☐ a kitchen (peacock)
- ☐ an indoor bathroom
- ☐ an outdoor bathroom
- ☐ a north pavilion (meten/bale naja)
- ☐ a rice attic (lumbung/fineng)
- ☐ a ceremonial pavilion (balé dangin)
- ☐ a guest-house or a west Pavilion (balé dauh/balé tiang sanga)
- ☐ a South pavilion (bale sakenam)
- ☐ Autre : _____

18. From your point of view, what are the pros and cons of bamboo construction :

19. From your point of view, rank by price similar size constructions (1 being the cheapest, 4 the most expensive)*Une seule réponse possible.*

- ☐ Concrete structure
- ☐ Brick structure
- ☐ Timber structure
- ☐ Bamboo structure

20. From your point of view, a bamboo house lasts...*Une seule réponse possible.*

- ☐ Less than 5 years
- ☐ Between 5 to 15 years
- ☐ Between 15 to 25 years
- ☐ Between 25 and 50 years
- ☐ About 50 years
- ☐ Way more than 50 years

21. **Is there, where you live, a regulation on construction which keeps you from building with bamboo?**

Une seule réponse possible.

- ☐ Yes
- ☐ No
- ☐ I don't know

22. **If so, could you tell us more about this regulation:**

23. **Do you know anyone who owns a bamboo-building?**

Une seule réponse possible.

- ☐ Yes
- ☐ No

24. **If so, what do you think about it?**

Thank you!

Thank you very much for your participation to this study. If you have anything to add to your answers or any question, feel free to contact us by e-mail : a.mertens@student.uliege.be

B. SURVEY FORM – BAHASA INDONESIA

Survei preferensi konstruksi

Survei preferensi konstruksi

Survei ini berlangsung sebagai bagian dari penelitian untuk tesis master di bidang teknik dan arsitektur.

Kami bertujuan untuk mempelajari praktik pembangunan di daerah tropis, terutama Bali, Indonesia.

Formulir ini perlu waktu sekitar 5 hingga 10 menit.

Pertama, kami ingin tahu sedikit tentang Anda.

Jangan khawatir, kami jamin data ini hanya akan membantu kami dalam konteks program penelitian universitas.

1. Saya... *

- ☐ kurang dari 15 tahun
- ☐ antara 15 dan 30 tahun
- ☐ antara 31 dan 50 tahun
- ☐ antara 51 dan 70 tahun
- ☐ lebih dari 71 tahun

2. Berapa umur anda?

3. Silahkan tulis pekerjaan anda di bawah? *

4. Saya tinggal *

- ☐ sendiri
- ☐ dengan suami atau istri
- ☐ dengan teman
- ☐ dengan keluarga
- ☐ Lain :

5. Berapa orang yang tinggal di rumah anda:

Survei preferensi konstruksi

6. Saya dari *

- ☐ Bali
☐ luar Bali
☐ Asia
☐ Lain : _____

7. Tinggal dimana *

- ☐ di Bali
☐ di luar Bali
☐ di Asia
☐ Lain : _____

Saya cari tahu lebih banyak tentang rumah anda,
Sekali lagi, informasi ini hanya akan digunakan untuk tujuan penelitian!

8. Jika Anda tinggal di Bali dimana ?

- ☐ Denpasar
☐ Tabanan
☐ Klungkung
☐ Karangasem
☐ Jembrana
☐ Gianyar
☐ Buleleng
☐ Bangli
☐ Badung
☐ Lain : _____

9. Saya tinggal di... *

- ☐ rumah sendiri
☐ rumah sewa
☐ rumah keluarga
☐ kost
☐ Lain : _____

Survei preferensi konstruksi

10. Di rumah anda, ada

- ☐ dapur
- ☐ kamar mandi dalam
- ☐ meten/bale naja
- ☐ lumbung/jineng
- ☐ balé dangin
- ☐ balé dauh/balé tiang sanga
- ☐ bale sakenam
- ☐ Lain : _____

11. Sebagian besar dari rumah anda terbuat: *

- ☐ Batu bata
- ☐ Beton / Concrete
- ☐ Kayu
- ☐ Bambu
- ☐ Lumpur
- ☐ Baja
- ☐ Lain : _____

12. Rata-rata rumah tetangga saya terbuat dari *

- ☐ Batu bata
- ☐ Beton / Concrete
- ☐ Kayu
- ☐ Bambu
- ☐ Lumpur
- ☐ Baja
- ☐ Lain : _____

Survei preferensi konstruksi

13. Jika anda ingin membuat rumah, material apa yang anda pilih? *

- ☐ Batu bata
☐ Beton / Concrete
☐ Kayu
☐ Bambu
☐ Lumpur
☐ Baja
☐ Lain : _____

14. Sebutkan 3 kata yang muncul pertama kali di pikiran Anda tentang rumah bambu: *

15. Jika ingin menambah bangunan rumah anda, apakah anda ingin membuatnya dari bambu? *

- ☐ Ya
☐ Tidak
☐ Tidak tahu
☐ Ya, kalau
☐ Lain : _____

16. Jika ya dengan syarat, jelaskan syaratnya

17. Jika tidak, kenapa?

Survei preferensi konstruksi

18. Jika anda ingin menggunakan bambu, bagian mana yang akan dibuat?

- ☐ dapur
☐ kamar mandi dalam
☐ meten/bale naja
☐ lumbung/jineng
☐ balé dangin
☐ bale dauh/bale tiang sanga
☐ bale sakenam
☐ Guest house
☐ hanya untuk lantai atau dinding
☐ hanya untuk atap
☐ Lain : _____

19. Dari sudut pandang Anda, apa keuntungan dan kerugian dari konstruksi bambu:

20. Dari sudut pandang Anda, berikan peringkat berdasarkan harga konstruksi dengan ukuran yang sama:

| | Tidak tahu | termurah | murah | terjangkau | mahal | paling mahal |
|------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Batu bata | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Beton / Concrete | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Kayu | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Bambu | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Lumpur | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Baja | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

21. Dari sudut pandang Anda, rumah bambu bisa bertahan berapa lama ?

- ☐ kurang dari 5 tahun
☐ antara 5 dan 15 tahun
☐ antara 15 dan 25 tahun
☐ antara 25 dan 50 tahun
☐ lebih dari 50 tahun
☐ Lain : _____

Survei preferensi konstruksi

22. Di mana Anda tinggal, apakah ada peraturan tentang konstruksi yang membuat Anda tidak bisa membangun dari bambu?

- ☐ Ya
☐ Tidak
☐ Tidak tahu

23. Kalau ya, jelaskan

24. Apakah Anda kenal seseorang yang memiliki bangunan bambu?

- ☐ Ya
☐ Tidak
☐ Lain : _____

25. Kalau ya, apa pendapat Anda tentang itu?

Terima kasih!

Terima kasih banyak atas partisipasi Anda dalam studi ini. Jika Anda memiliki sesuatu untuk ditambahkan ke jawaban Anda atau pertanyaan apa pun, jangan ragu untuk menghubungi kami melalui email: a.mertens@student.uliege.be

C. INTERVIEW GRIDS

C.1. IN-DEPTH INTERVIEWS OF EXPERTS

| In-depth interview with the experts (engineer, architect, owner of a bamboo house) | | |
|---|---|---|
| Reading and signature of the consent form. | | |
| First contact, first name, place of life, age, job / occupation. Offer a drink. | | |
| <p>Dans quel contexte avez-vous fondé Asali?</p> <p>Choix du bambou?</p> <p>Public ciblé ?</p> <p>Durée de vie du matériaux ?</p> <p>Budget bambou traité vs. Non traité ?</p> <p>Budget construction de 30 à 50m² ttc ?</p> <p>Comment le bambou est-il reçu par la population locale pour le projet de l'éco-village ?</p> | <p>What brought you to us bamboo in your projects?</p> <p>What kind of public do you aim? What kinds of functions for your buildings?</p> <p>What is the range of cost of a bamboo house?</p> | <p>What is your house made of?</p> <p>Where do you find your bamboo? Is it easy to find?</p> <p>Is the bamboo you use treated?</p> <p>Did you encounter any maintenance problems? Termites?</p> |
| <p>What is your own home here in Bali?</p> <p>How was it received by your neighbours?</p> | | |
| <p>In your opinion, is bamboo acceptable to the Balinese population?</p> <p>If no, what are the drawbacks?</p> <p>What is the legal framework around the bamboo construction?</p> <p>What is the lifespan of a bamboo house ?</p> | | |
| Thanks & drink – End and goodbye (offer to send some news if person seems interested) | | |

C.2. IN-DEPTH INTERVIEWS A PRIORI

| In-depth interview a priori | Focus |
|---|--|
| Description of the process. Explications of the context in which the collected data will be used. Signature of the consent form. | <i>Reassure the interviewee,</i> |
| First contact, first name, place of life, age, job / occupation. Offer a drink. | <i>Collect the personal information on the interviewee and try to make them comfortable,</i> |
| <p>Could you tell me about your home ? How many people do you live with?</p> <p>→ What conveniences do you have? (outdoor/indoor bathroom, kitchen, rooms etc.)</p> <p>What is your home made of?</p> | <i>Their house and personal standards,</i> |
| Construction in Bali: what would you say is the most used construction material in Bali? What are the pros and cons of this material? | <i>Their general vision on construction material in general,</i> |
| If you were to build a new construction at home without any kind of restriction (in terms of | <i>Their ideal material(s) and why.</i> |

| | |
|---|--|
| budget or regulations), which materials would you choose? | |
| <i>Small break if necessary.</i> | |
| Now, if I ask you about bamboo construction, what comes to your mind first? | <i>Perception/ key words/ ideas/ clichés on bamboo construction,</i> |
| Would you build with bamboo? | <i>Opinion of bamboo construction,</i> |
| If one of your neighbours were to build in bamboo, how would you feel about that? | <i>Social acceptability of the material,</i> |
| What would you think is the cheapest and the most expensive amongst concrete, brick or bamboo construction? | <i>Cost perception,</i> |
| How long does a bamboo house last? | <i>Durability perception,</i> |
| Can you think of any other barrier to using bamboo as a construction material? | <i>Other criteria (negative),</i> |
| Can you think of any strong incentive encouraging the use of bamboo as a construction material? | <i>Other criteria (positive),</i> |
| What are the first thoughts that come to mind with these pictures? | <i>Photo elicitation,</i> |
| To sum up, could you remind me the pros and cons of bamboo construction (compared to...)? | <i>Redundancy to validate what was said or add some criteria.</i> |
| Thanks & drink – End and goodbye (offer to send some news if person seems interested) | |

C.3. PHOTO-ELICITATION IMAGES



BAMBOO GAZEBO, TOKOPEDIA,

[HTTPS://WWW.TOKOPEDIA.COM/FASTURE/GAZEBO-BAMBU?M_ID=17019540](https://www.tokopedia.com/fasture/gazebo-bambu?M_ID=17019540)



JL BAHAY KUBO AND BAMBOO CRAFT,
PANGASINAN, PHILIPPINES, PHOTO FROM [HTTPS://TRETRUCTHIENPHUC.COM/](https://tretructhienphuc.com/)



PP HILL BAMBOO BUNGALOW, BAHAY KUBO
DESIGNS, KO PHI PHI DON, THAILANDE, PHOTO FROM [HTTPS://WWW.BEDANDBREAKFAST.EU/](https://www.bedandbreakfast.eu/)



BAMBOO HOUSE, H&P ARCHITURE,
VIETNAM, PHOTO FROM [ARCHDAILY.COM](http://archdaily.com)



BAMBOO YURT, BAMBOOU

WORKSHOP, BALI, PHOTO FROM INSTAGRAM



DD BAMBOO LODGE BALI, GIANJAR,

PHOTO FROM AIRBNB.



DD BAMBOO LODGE BALI, GIANJAR, PHOTO FROM

AIRBNB.



BOOKING.COM

LE BAMBOO BALI, ULUWATU, BALI, PHOTO FROM



PHOTO BY RIO HELMI

GREEN VILLAGE, BY IBUKU, BALI,



ECO BAMBOO HOME, BALI, PHOTO FROM [HTTPS://MOVINGTAHITI.COM/DECORATION/LECO-BAMBOO-HOME-UNE-CABANE-TROPICALE-A-BALI/](https://movingtahiti.com/decoration/leco-bamboo-home-une-cabane-tropicale-a-bali/)



BAMBOO CABIN "PETITE COCOON",

PHOTO FROM [HTTPS://WWW.BAMBUS.A.FR/PETITE-COCOON-TOIT-BARDEAU-EN-BAMBOU.HTM](https://www.bambusa.fr/petite-cocoon-toit-bardeau-en-bamboo.htm)



PREFABRICATED BAMBOO HOUSE,

PHOTO COURTESY OF ASALI BALI



PREFABRICATED BAMBOO HOUSE,

PHOTO COURTESY OF ASALI BALI



PANYADEN SCHOOL, CHIANGMAI

LIFE CONSTRUCTION, <https://www.bamboo-earth-architecture-construction.com/portfolio-item/panyaden-school/>

C.4. COMMENTED WALKS

- 7- Define the instructions relating to the description and the duration of the experiment,
- 8- Re-explain the context of the study (master thesis),
- 9- Launch the cameras and the Dictaphone,
- 10- Present a scenario to the potential user: they are told to imagine that these buildings are their own. The first one is presented as an extension to their current house. What function would they like it to be for?
The second visited building is a whole new home for them.
They get to discover the spaces and are asked to explicitly comment the feelings, sensations, thoughts and opinions about it. Does it correspond to their expectations for a new building of their own?
- 11- Insist on their sensory perceptions: What do they think of the place? How do they feel? What does it smell maybe? They are asked to give a sensory feedback (visual, olfactory, sound, touched).
- 12- Return to the site if possible to identify in detail the conditions from which appear phenomena described by passers-by, reversing the relationship between observation and description: it is no longer a question of describing what one perceives but of relating the descriptions to what is observable on the spot (Thibaud, 2001).

For the sake of this research, as the owner of the house visited in the commented walks doesn't want his identity to be disclosed, his name will not be mentioned in the transcripts.

C.5. IN-DEPTH INTERVIEWS *A POSTERIORI*

| In-depth interview <i>a posteriori</i> | Focus |
|--|--|
| How did you feel throughout the visit we just made? | <i>Get a feedback on the emotional state during the visit,</i> |
| Would you build with bamboo? Why? | <i>Compare with the previous answer to observe if there is an evolution in the answers (same for following questions),</i> |
| If one of your neighbours were to build in bamboo, how would you feel about that? | <i>Social acceptability,</i> |
| How long do you think a construction like this might last? | <i>Durability perception,</i> |
| If you changed your mind, what was the trigger? | <i>Change of perception or/and acceptance, indicator of qualitative housing,</i> |
| Can you think of any strong incentive encouraging or something that could stop you from using bamboo as a construction material? | <i>Other criteria,</i> |
| What is, in your opinion, the range of cost of bamboo construction? | <i>Cost perception,</i> |
| To sum up, could you remind me the pros and cons of bamboo construction (compared to...)? | <i>Redundancy to validate what was said or add some criteria.</i> |
| Thanks & drink – End and goodbye (offer to send some news if person seems interested) | |

D. TRANSCRIPT 1 – INTERVIEW OF CHIKO WIRAHADI PURNAWAN PART 1

[00:01] Audrey: Hello again. I'd like you to present yourself shortly, your name and what you do for a living.

[00:09] Chiko: My name is Imade Wirahadi, but usually they call me Chiko Wirahadi. My main job is architect, doing some design and build but doing some specialise in bamboo or other eco-friendly material. So we have design and contractor and sometimes doing some furniture and interior design.

[00:44] Audrey: For how long have you been working with bamboo?

[00:47] Chiko: I think starting in 2005. Starting when I still work in a company. So the company is really really into the eco-friendly business. But the basic is in jewellery.

[01:13] Audrey: What's the name of the company?

[01:14] Chiko: John Hardy Jewellery. They call indah. Beautiful craftsmanship. So their basic main business is jewellery. But they are doing some building and doing some other supporting jewellery always in the eco-friendly business.

[01:43] Audrey: Why did you personally, as an architect on your own, decide to use bamboo as main construction material?

[01:54] Chiko: So in the beginning I'm not really into the architecture. So after graduate... architect in Bali is a bit hard. When they not appreciate the design process very much. They just want to see the building. So I go to construction business like building housing and some spa buildings but mostly so standard like everybody's doing like using concrete, bricks, blocks and steel. And then I get bankrupt, I get bankrupt in the beginning. So I started working when I'm still being a student. That's why I spent 7 years. It's supposed to be 4 or 5 years because I stopped doing my thesis. So I worked and doing business, that one. Some project not going well so I had to go working somewhere. Then I go submit to the one company called John Hardy Jewellery. That's four... uhh the beginning of 5 years. Five years starting doing the special project apartment. So not handling the main business but just supporting the business and doing some experiments.

[03:39] Audrey: So that is what brought you to bamboo?

[03:42] Chiko: Yes because every day we work with eco-friendly material. So we don't allow to using wood, we don't allow to using plywood, we don't allow to... It's like you go to concentration camp and you cannot do this, you cannot do that. You have to do this. It's like a brain wash.

[04:10] Audrey: And now that you work on your own, you still use bamboo as you were taught when you were working with that company? Now that you are on your own, you still use bamboo most of your projects?

[04:23] Chiko: Yes, mostly like 90% is still using bamboo.

[04:32] Audrey: Ok. What kind of public do you aim? Your clients, are they Indonesian? Are they foreigners? Are they Balinese or not?

[04:45] Chiko: Mostly mix. Some foreigners and some local.

[04:54] Audrey: Like 50-50?

[04:57] Chiko: Yes 50-50.

[04:59] Audrey: What kind of buildings do they build in bamboo? Is it more housing or commercial building or restaurants or...

[05:10] Chiko: Usually before, started more bamboo in commercial like. But in the last 3 years, they became housing. So in the beginning of... So I started my own business 7 years. So in the beginning 3 or 4 years, half of that, they still use bamboo for the front of the house but not the housing because they are still thinking about the maintenance and how long they can stay strong, the lifespan and things like that. But now in the last in 3 years, we are starting to promote some housing through... into the hospitality

business, it's working but housing more. And become after housing space, is they more receive bamboo now and starting the components like small culms and things like that.

[06:30] Audrey: You were talking about the lifespan of the material. How long would you say that is for bamboo buildings?

[06:39] Chiko: So for the standard of the treated well is like 15 to 20 years but I think still can get way more than 20 years if you're doing the maintenance during the 15 years very good. And maintenance very good and there are some special traditions of bamboo that can take more than 20 years.

[07:18] Audrey: Would you mind answering questions about the budget of these constructions?

[07:22] Chiko: Uh-uh.

[07:23] Audrey: For a small kind of construction of housing type of about 30 meter square? 30 to 40, how much would you say that costs?

[07:39] Chiko: When we are doing some budgeting, when we are talking about housing and public spaces is a bit different. Because when housing there's a lot of like walls and indoor details. Usually we but some average for public buildings 3 to 4 million per meter square and for the housing like 4 to 5 million per meter square. It depends of the spec, there is a lot of unusualness materials for the spec.

[08:16] Audrey: And now, about your own house here in Bali, what is it made of?

[08:22] Chiko: My house is made from concrete because I designed this house like 20 years ago when I'm still a student and it's a bit like tied and then I design this house it's already concrete and we used wood too, we used traditional standard Bali house material and Balinese carving and things like that.

[09:00] Audrey: And if were to build an extension to your house, which material would you choose?

[09:04] Chiko: I'm still using, thinking about not bamboo in this house because it's not fit on with the building itself. And uh the durability of the bamboo of you put in my first house it would be not matching. Maybe for some decoration like interior...

[09:34] Audrey: Ok, bamboo for...

[09:35] Chiko: Yes just like for some decoration.

[09:38] Audrey: How would you think, if someone in the neighbourhood built a house in bamboo, the neighbours would react?

[09:52] Chiko: If it's bamboo in my neighbour it would be very different from all the buildings in my neighbourhood. I think it's like surprisingly different.

[10:13] Audrey: Good surprise or bad surprise?

[10:15] Chiko: Yes good surprise.

[10:18] Audrey: Maybe some people would not like a bamboo house to be in their neighbourhood?

[10:24] Chiko: No I think in this... as long as the government give their permission, still okay.

[10:31] Audrey: Okay. About the government, are they like barriers to constructing in bamboo? Like regulation that would stop you from building in bamboo?

[10:44] Chiko: No, no, because in a statement of government there is a really strict in Bali to using local material and I think bamboo is local material. Just but might be a bit constraint for them is about the shape. That is cannot, still they cannot the shape do something about the shape is not too Balinese architecture.

[11:12] Audrey: So they would stop it if it was forms and shapes...

[11:18] Chiko: Too far from the Balinese traditional architecture.

[11:27] Audrey: So in your bamboo projects here in Bali, have you met some barriers and administration saying they don't like that shape?

[11:38] Chiko: In Bali, we don't handle the permit, usually the client is handling the permit for the bamboo.

[11:47] Audrey: And you've never had problems with that?

[11:50] Chiko: Until now no. Not yet. But there's some going to be going through. Because they put me to become one of the investors the owners, I have to be responsible too for submitting the permit. But maybe it'll be a little bit different in the shape to fit more with the Balinese.

[12:24] Audrey: Would you say that bamboo is an acceptable material for Balinese people or not?

[12:34] Chiko: Before, we used bamboo a lot. But before the people found how to treat bamboo for more long lasting, so it's only taking 2 or 3 years and then it gets rotten. But the traditional Bali house treatment, they have to dip the bamboo in the water and then it takes like 4 months to build. And then there is bamboo that became... there was a lot of problem with the hygiene, hygienic, like a lot of rats inside the bamboo and so people got sick so it becomes in their heads it's for poor people not for the rich people using concrete and fancy, fancy ceramic and things like that.

[13:36] Audrey: Would you say that that could change, the vision of bamboo as a poor material, could it change?

[13:44] Chiko: Yes, because the next generation will be more... After the grandma pass away I think nobody will say: "What kind of house is that?" "You know? After maybe the next generation. The good is there is a lot of foreigners starting that one because they already through all the fancy buildings that destroyed the earth. They are taking the mountains and cutting the mountain to get the fancy house and then they realize. And now they are using bamboo in their business and now the local people go : "Ooooh, that's fancy, is that possible? Ooooh". There's a kind of like style in Indonesia like to follow Americans, to follow Europeans it's like a lifestyle, right? To be more the fancy. If the European and American are using bamboo then ooh okay now it becomes fancy.

[14:49] Audrey: Ok good. Thank you. We'll take a 5 minutes break to drink a bit but we are more than halfway through.

E. TRANSCRIPT 2– INTERVIEW OF CHIKO WIRAHADI PURNAWAN PART 2

[00:15] Audrey: If I ask you about the three big words that come to your mind whilst talking about bamboo construction? Like if you had only three words to describe bamboo construction?

[00:30] Chiko: Words, only words? Only one word?

[00:35] Audrey: Three. Oh but you can have small phrases yes.

[00:42] Chiko: One would be local empowerment, number two sustainable and number three is uh... free design... No not free design, creativity!

[01:14] Audrey: Thank you. Now could you rank by price these three types of constructions? Which one is the cheapest, which one is the most expensive?

[01:28] Chiko: With the standard? I mean this can be very expensive but can be cheap.

[01:35] Audrey: Ok but like same size and same types of construction?

[01:39] Chiko: Ok standard. Well... [sorts out the pictures]

[01:46] Audrey: Ok this would be the rank?

[01:48] Chiko: What is the difference between this and this one?

[01:50] Audrey: These are bricks, with basically mud that you bake, and this is concrete so it's more or less cement, sand, rocks and water.

[02:05] Chiko: I think this one. One, two, three.

[02:11] Audrey: This would be most expansive or cheapest?

[02:14] Chiko: Cheapest.

[02:16] Audrey: So concrete cheapest, bamboo intermediate, and bricks the most expansive.

[Chiko asks Audrey what is in her point of view the rank. Then Chiko's assistant interrupts to say goodbye before the Nyepi holidays]

[03:09] Audrey: Now which one would you say lasts the longer, and you said this could last a lifetime but like compared to the other ones?

[03:32] Chiko: This one. Lifespan, the lowest, the highest.

[03:38] Audrey: Bamboo, bricks and concrete, concrete the longer. Now do you think that there are some criteria? I think you already almost answered before but I'm asking again. Things that could really change people, local mentality on bamboo? What would those be? To bring back value of the material for local people?

[04:13] Chiko: Sorry. Could you repeat please?

[04:14] Audrey: What would be a mind change?

[04:23] Chiko: I think if we... keep campaign about bamboo. Keeping using bamboo and things like that. To people, so now is now interesting design. In hospitality very strong about the creativity. So the creativity can accommodate by the bamboo design. The more I make some crazy things, I think they are going to accept it. Because they need something new every day, every week. They're looking something new in the world. Change is like that, in the world. So I'm keeping doing my creativity everyday making something new, I think that can be the change their minds.

[05:21] Audrey: What would you say are strong disadvantage of bamboo? What is it not good for?

[05:33] Chiko: There is still about the durability when it's outside, under the rain, under the water, like outdoor... or something like that. It's really weak.

[05:47] Audrey: If the design is good and the bamboo is protected, can you think of other disadvantages?

[05:55] Chiko: No, if it is already inside or under the roof, it will be only advantages. Now I'm still testing that bamboo, uh, there must be a way, I'm still trying something to make it strong for the outdoor. It is still it's weakness, in the outdoors.

[06:17] Audrey: Now I'm going to ask you to go through this pictures. You can choose three pictures but if you want to pick more you can. And just tell me what you think, what does the picture make you think about.

[06:35] Chiko: Every picture, we comment or...?

[06:37] Audrey: You don't have to do every picture. You can just choose three and if you want 4 or 5, you can comment them too. Is there something strong coming to you with one of the pictures, you can just comment it.

[07:04] Chiko: [goes through the pictures] These three pictures right.

[07:23] Audrey: Thank you.

[07:27] Chiko: So I like the one not all bamboo, it's combined to another material. It's very rich when it's not full bamboo, there's another material that... but still I like the one more sustainable material. This one my dream to make a connected house like ship in around the world and then just build up in like under a week or something like that and people can have a house. And that's why I chose these two.

[08:07] Audrey: Ok for prefab then?

[08:08] Chiko: Yes these houses.

[08:10] Audrey: Ok. Good, nice. Well thank you. I'm done.

[08:19] Chiko: And also for the disasters and things like that, if there's some... some... in Indonesia there's a lot of disasters, right? So this kind of building will be helpful if I have a good simple design and cheap, that can help people to get a home in like a week so government can pay me in and be helpful.

[08:45] Audrey: To sum up, can you remind me the pros and cons of bamboo? Like good sides and bad sides of bamboo? Remind the qualities and disadvantages? Wait, I'm gonna translate, I have the words here somewhere in Indonesian.

[09:50] Chiko: The advantage is faster than other constructions that I think because I don't like to be in project too long. So I like fast project. Like one year and it's just brick by brick and somethings like that. Kerugian [disadvantage in Bahasa Indonesia] is like because we have to build the chain. So that's the one: it's not, the material we cannot directly buy it at the shop, we have to prepare. Because if we stop, it cannot be stopped too long or something like that.

[10:53] Audrey: Ok that's it. We're good, thank you!

F. TRANSCRIPT 3 – INTERVIEW OF THIERRY CAYOT, FOUNDER OF ASALI BALI

[00:07] Audrey: Alors, Thierry, est-ce que tu peux rappeler ton rôle ici dans la société Asali ?

Thierry: Bien je l'ai fondée en 2003, j'ai fondé en 2003... Tu enregistres là ?

[00:17] Audrey: Oui.

Thierry: Ah d'accord ok. Je l'ai fondé en 2003 et à peu près en 2010 on a tourné vers le bambou. D'abord de la déco et puis on est arrivés très rapidement à faire de la construction, et très rapidement amené à partir de 2012 à se positionner sur des gros bâtiments en bambou.

[00:41] Audrey: Alors qu'est ce qui t'as amené au choix du bambou?

[00:21] Thierry: L'éthique. De prouver qu'on peut être une entreprise profitable et être « neutral carbon ». Essentiellement. Alors évidemment l'étude de marché était positive hein, je suis un businessman quand même avant tout. Mais c'était vraiment montrer qu'on peut... enfin bon dormir avec me conscience tranquille et plus toucher à la forêt même si avant, je ne travaillais qu'avec des meubles... enfin qu'avec des forêts plantations.

[01:11] Audrey: En bois?

Thierry: En bois, en Teck.

[01:15] Audrey: Donc ici, le contexte balinaï t'a aussi influencé vers le choix du matériau ?

Thierry: Pas du tout. Enfin si parce qu'il était disponible et j'en vendais déjà en déco dans ma plateforme web, « the market place » de décoration en France avant donc on vendait déjà du bambou. Et évidemment ça m'a influencé de voir le bambou sous toutes ses formes dans les temples, tout ce qu'on peut y faire et cetera, ça a toujours été séduisant.

[01:49] Audrey: Au niveau du public ciblé par la société, est-ce que tu peux nous en dire un mot ?

Thierry: Alors du tourisme plutôt haute gamme. Heu... Olivier pourra te donner les pourcentages vraiment de nos clients l'année dernière. Je crois qu'on est à 40% tourisme haute gamme, 20% bâtiments industriels et 10% de résidentiel et le reste de la petite... des petites choses.

[02:22] Audrey: Pour le public résidentiel, c'est principalement...

Thierry: Des étrangers.

[02:31] Audrey: D'accord. Alors au niveau de la durée de vie du bambou, une fois qu'il est traité, on peut atteindre une durée de vie comme matériau de construction...

Thierry: Alors ça dépend si c'est bien conçu ou pas. Si c'est pas bien construit 5 ans, si c'est bien construit heu... « lifetime »

[02:49] Audrey: Ok d'accord. Du moment que, si on fait l'hypothèse que le design est bien conçu et que le matériau est utilisé au maximum de ses capacités...

Thierry: Et bien traité, effectivement. Sachant que les trois principaux points, il y pas que ceux-là, il ne faut pas de contact permanent avec l'humidité comme par exemple un bambou en contact sur du ciment par terre, ou encore pire du sol et pas soleil, pas d'exposition direct au soleil. Tu peux chercher dans le bâtiment il y a un bambou qui est en exposition au soleil...

[03:22] Audrey: Par « lifetime », tu entends combien d'années ?

Thierry: Ben écoute, moi je peux te donner l'exemple du frère du grand-père de ma femme balinaise qui vient de mourir et il habitait dans une maison en bambou. Et il dit qu'elle était construite avant qu'il soit né. Il est mort à 85 ans. Et en utilisant des méthodes traditionnelles qui sont fort respectables mais sachant que ici, ce qu'on fait, c'est de rajouter de la technologie de l'ingénierie au-dessus des méthodes traditionnelles que l'on respecte fortement bien entendu.

[03:59] Audrey: Au niveau du budget pour une construction en bambou : traité vs non traité, la différence de budget elle est de à peu près combien?

Thierry: C'est impossible à répondre. Olivier te répondra des fourchettes parce que ça dépend du design, ça dépend des matériaux que tu utilises, ça dépend des finitions, ça dépend de certaines choses. Ça peut aller de 1 à 10, c'est une question difficile à répondre comme ça.

[04:25] Audrey: Donc si je te dis entre 30 et 50 mètres carrés de surface couverte ?

Thierry: Tu peux compter entre, vraiment du super basique pour nous, entre 1 million et 5 million du mètres carrés.

[04:45] Audrey: Dans quelle devise?

Thierry: Roupie, en comptant la structure, le toit, les murs. Voilà.

[04:55] Audrey: Alors maintenant Thierry, de quoi est faite ta propre habitation à Bali?

Thierry: Moi j'ai hérité d'une maison qui était déjà achetée qui était une maison balinaise, en fonction du Feng Shui balinaise, avec des tuiles et des pierres rouges balinaises et cetera. Là je viens de construire une autre maison qui... que j'ai pas pu faire tout en bambou parce qu'elle était dans un terrain, dans un terrain où il a fallu que je fasse un mur de soutènement pour retenir la terre et donc c'était pas du tout souhaitable. Donc j'ai fait juste la charpente en bambou sachant que la charpente est une excellente application pour le bambou. Ceci dit avant, pendant 10 ans, j'habitais dans une maison que j'ai construite en bois que j'ai achetée à Java, que j'ai remonté ici. J'ai complété tout le reste en bambou : les cloisons, le toit, les rafters, le plancher.

[05:55] Audrey: Et comment est-ce que ça a été reçu par tes voisins, quand tu as construit en bambou ?

Thierry: Bien ! Mes voisins... ça dépend de qui. Des voisins occidentaux, super. Les voisins balinais : perplexes. Enfin il trouve pas bien mais il ferait pas ça pour eux.

[06:19] Audrey: Donc je te pose quand même la question telle quelle: selon toi le bambou est-il acceptable ou non pour la population balinaise? Et sinon quelles sont les freins?

Thierry: Clairement non, clairement non. Et les freins sont essentiellement culturel. C'est que le bambou est considéré comme le matériau du pauvre parce que les gens qui n'avaient pas d'argent pour construire en bois ou en dur ben construisaient en bambou, et le bambou quand il est mal construit, quand il n'est pas traité et qu'il est mal construit, a une durée de vie très limitée de 4 - 5 ans. Donc c'est vraiment le..., je ne sais pas comment on dit en français, mais le « poor man material » construction. Et ça c'est culturelle, c'est très ancré. On a déjà construit pour des indonésiens des de projet en bambou mais des indonésiens de haute culture, très cultivés dont notamment un directeur d'école. On a fait une école de 50 mètres de long. Bon c'était quelqu'un qui était complètement informé et cultivé mais dans les classes moyennes par exemple dans mon village ils sont tous... Ils ne savent pas quoi répondre quand je leur montre mon toit en bambou. Ils ne comprennent pas, c'est même un notre monde pour eux. En général le bambou, si tu veux, il est utilisé dans les temples pour toutes les cérémonies pour des choses temporaires: faire des temples temporaires, faire des supports temporaires, faire des tables temporaires. Et puis à la fin de la cérémonie on jette tout.

[08:00] Audrey: Est-ce que, à ta connaissance, il y a des freins d'ordre administratif, régulation...

Thierry: Pas du tout, il n'y a pas de problème de régulation en Indonésie ce qui est un bon point pour nous.

[08:11] Audrey: Maintenant est-ce que tu penses que par l'exemple on peut faire évoluer la vision que les Indonésiens ont du matériau?

Thierry: Sur le long terme, moi j'ai mon expérience de 10 ans de faire des grands bâtiments en bambou, et c'était mon idée. C'était: Quand on montre des bâtiments qui ont 16 m de portée comme celui-ci fait en bambou ben ça commence à secouer la conscience, ça secourt ce qu'on a. Donc c'est l'idée, c'est que il n'y a pas besoin de parler quand on voit des grands bâtiments en bambou comme ça. On se dit on peut faire ça en bambou ça veut dire que le bambou a quelque part des qualités. Bon, le gros frein qu'on a, c'est la durabilité. C'est-à-dire que pour des projets touristiques qui sont des projets de business, qui sont investis sur 10 ans on va dire, ça pose pas de problème. Pour les maisons d'habitation, on a eu souvent, même des occidentaux, pas

mal de refus de client sur des projets avancés parce que ils n'étaient pas sûrs de la durabilité, c'est quand même une maison. Il faut que ce soit en dur et cetera. Même chez nous il y a ce frein qui existe, je dirai encore plus chez les indos.

[09:22] Audrey: D'accord. Et alors au niveau de l'éco-village, dont il est question dans ton projet au sein de ton village, est-ce que tu peux nous en parler un petit peu?

Thierry: Alors c'est un projet qui s'appelle Sadar Wisata, c'est-à-dire le tourisme conscient, on part de loin. C'est un projet que j'ai initié auprès du maire du village qui la pris en main. On a monté un groupe, avec quelques potes, un groupe dans le sein du village avec les gens qui ont un peu de compétences, des drivers, dans le domaine du tourisme et des choses comme ça. On part vraiment de très très loin. donc c'est un projet sue lequel j'ai un support d'un ami qui est en thèse en nano-tourisme qui est en autrichien et qui m'aide à monter le master plan sur ce projet. C'est pas du tout évident, il y a des mentalité à changer, il y a différents aspects je vous avais dit que on est dans une zone qui est protégée donc on peut pas faire n'importe quoi . Protégée par le patrimoine mondial de l'humanité, les rivières de Jatiluwih, ça va jusqu'à notre village.

On a des freins de la population locale, ils ne comprennent pas. Moi, ma seule motivation sur le projet là, c'est de trouver... c'est la seule économie je dirais un peu sexy que j'ai trouvé pour, avec la culture organique que j'essaye de développer dans le village, pour qu'il y ait des emplois qui soient créés pour les jeunes dans le village et que ils ne se barrent pas tous en ville, et que cette culture qui est magnifique - culture orale vivante la nuit des temps, j'ai envie de dire - toujours entièrement vivante, ne soit pas perdue en une ou deux générations comme ça a été le cas dans certaines campagnes françaises, notamment la mienne en Bretagne.

[11:07] Audrey: D'accord. Je reviens une petite minute sur les freins par rapport au fait que il s'agit d'un site classé à l'Unesco. Est-ce que tu sais m'en dire plus sur ça?

Thierry: On ne peut pas transformer les rizières en zone constructible. Le problème, c'est que toutes les zones à peu près plates ont déjà été transformées en rizière. Et que donc il ne reste que des terrains qui sont en pente, par exemple. Bon, pas que... mais ça pose quand même des problèmes d'implantation sur le master plan niveau architecture. Maintenant sur l'architecture bambou, c'est possible. Le projet a 3 axes, il y a un axe de développer des homestays. Comment est-ce qu'on dit en français des homestays?

[11:55] Audrey: Des auberges?

Thierry: Non, non, des accueils chez l'habitant là, il y a tout un réseau en France pour ça. Bon, des homestays. Des villageois qui vont recevoir...

[12:08] Audrey: Des maisons d'hôte, des gîtes ?

Thierry: Des maisons d'hôtes voilà, des gîtes, voilà exactement des gîtes. Et alors pour ça on va faire des plans d'architecture. Un sera en bambou mais comme ils ont du bois en local, du bois de plantation en local dans toutes les forêts qui sont aménagées autour, il est possible que la solution préférée soit en bois local. Et puis surtout ils ne savent pas travailler des bambous. Et puis les artisans bambou sont quand même des... moi je suis content, au compagnon de France, ils sont quand même très qualifié et assez exigeants finalement en terme de salaire. Donc l'avantage, c'est que si ils font leur homestay avec des plans, ils sauront faire leur homestay tous seuls avec des plans en cailloux local. Après je ne pousserai pas mais je proposerai la solution bambou, ça pourrait attirer certains.

[13:09] Audrey: Et selon toi, le fait de proposer le bambou dans ce cadre-là ça pourrait aussi participer à faire évoluer les mentalités?

Thierry: Déjà ce que je fais dans le village fait évoluer les mentalités. Les gens, quand ils voient ma charpente, c'est complètement à l'opposé de ce qu'ils pensent que le bambou c'est le matériau du pauvre, tu vois ? Parce que, bon, moi je ne vis pas dans une cabane. Alors du coup, pour eux, c'est très très étonnant. Non, oui, oui, oui, y a ça à étudier, à faire changer, à faire évoluer les mentalités... De là à ce qu'ils mettent du bambou dans leur maison, j'y crois pas trop. Sauf que certains mettent quand même des toits en Rafter, traditionnellement c'est vrai que ça s'applique bien.

[13:57] Audrey: Alors dernière question: il y a une certaine méfiance d'après ce que tu me dis concernant la durabilité du matériaux de la part des indonésiens. Est-ce que, à Asali, vous proposez une piste par rapport à ça, une garantie sur la durabilité ou quelque chose de style?

Thierry: Alors comme tout matériau naturel, comme tu le sais, en architecture, toute construction en matériaux naturels nécessite une maintenance. Cette maintenance, par l'ingénierie et le design, on essaie de la minimiser au minimum. Donc ce qu'on fait c'est qu'on garantit le bâtiment et cette garantie est liée à un contrat de maintenance qu'on fait nous par des visites, 2 fois par an, 3 fois par an, ça dépend des bâtiments, qui nous permettent de maintenir le bâtiment et donc de garantir la durée de vie du bambou. Donc tu vois ici c'est un bâtiment qui a déjà peut-être 5 ans. De temps en temps il y a une petite fuite. Tu vois, si on laissait la petite fuite, c'est sûr que tout le bambou avec l'eau, ça marche pas. On ne met jamais du bambou dans une salle de bain, c'est un non-sens. Il y en a qui viennent de nous demander de faire des bateaux en bambou, je leur dis d'aller voir ailleurs. Faut pas délirer non plus. Le bambou reste une herbe géante et donc n'a pas les capacités, les qualités techniques du bois, ou les mêmes que d'un mauvais bois. On gère ça parce que le matériaux a beaucoup d'autres intérêts, des capacités mécaniques par exemple en compression, en pression et cetera, sa forme, le design que cela apporte, les possibilités de design...

Donc beaucoup d'avantages en construction enfin surtout en construction dans le domaine touristique. Ceci dit il faut que ce soit extrêmement bien construit, la moindre erreur peut être catastrophique. Par exemple, avoir un bambou sur des fondations sans qu'il y ait un joint de capillarité, c'est quelque chose qui amène forcément le poteau à être pourri en 3 ans ou 4 ans, s'il est à l'extérieur, pour prendre un exemple, un petit exemple.

[16:38] Audrey: Et donc un contrat de maintenance, c'est sur une durée de combien de temps ?

Thierry: Et ben comme désire le client, c'est un an renouvelable et la garantie suit. Voilà donc c'est comme ça qu'on a fait. 1 an de maintenance 1 an de garantie, tu reconduis ton an de maintenance, on reconduit la garantie.

[16:55] Audrey: Parfait ! C'est tout ce dont j'avais besoin, merci.

G. TRANSCRIPT 4 – INTERVIEW OF PUTRA, OWNER OF A BAMBOO HOUSE IN BALI, INDONESIA

[00:01] Audrey: Can I ask you a few questions about your house?

Putra: Yeah sure.

[00:08] Audrey: Are you ok if I record you?

Putra: Oh my god. Ok.

[00:13] Audrey: It's for my studies. Where do you want to sit?

Putra: Right here.

[00:41] Audrey: My name is Audrey, I'm studying bamboo construction at school.

Putra: At ASALI.

[00:46] Audrey: Yes. And I'm writing a paper on bamboo construction. You are the only bamboo house owner that I could find.

Putra: Really?

[00:58] Audrey: Yes because it must be Balinese people.

Putra: You can see a lot of them. But I don't know...

[01:04] Audrey: Balinese owners?

Putra: Yes, it is difficult. Yes because they don't make it, they only sell it. The houses.

[01:14] Audrey: Can you remind me your name?

Putra: My name is Putra, Ketut Putra.

[01:19] Audrey: How old are you? If you don't mind saying.

Putra: I'm 36.

[01:25] Audrey: Ok you and your house is in bamboo?

Putra: Yes.

[01:29] Audrey: Is the structure in bamboo?

Putra: Uh uh.

[01:32] Audrey: So here you have bamboo as structure and you have other material? Can you tell me about it?

Putra: Yes for this houses, I like in bamboo because you know first all houses were all by bamboo. We don't use like concrete for that, my mantra is how local like people be back again like before, like 30 years ago, 40 years ago, 45 years ago, they all they use by bamboo. For example all the traditional houses in Bali, all they use by bamboo. Bamboo is really good and cheap also right? If it's not like a company open a big business, they are thinking only business. Now if they like to use all by bamboo, it is good for the good-looking. You can make a lot with imagination but also a simple house.

[02:39] Audrey: You have a business also with bamboo?

Putra: Yes.

[02:45] Audrey: Can you talk to me about it? Just a bit?

Putra: For my houses I make a model first. At least 2 years, from the model I make a real house. This is not so easy, with the ceremonies and everything, but I use hard by bamboo and hard by concrete.

[03:13] Audrey: Why do you use concrete?

Putra: Me? Because I have a small land not a big land. If the big land, all I use by bamboo. Because this side of my land, this is my uncle's land, I cannot use it. For that we cut by concrete. If we use bamboo we cannot cut for the land.

[03:36] Audrey: Where do you find your bamboo? Is it easy to find?

Putra: Very easy, from the farmers.

[03:45] Audrey: In Belega?

Putra: No in [name of a Balinese village] and Tabanan. They have a lot.

[03:54] Audrey: Do you treat the bamboo you use?

Putra: Yes. I treat bamboo, you know, by Borax. For the fast.

[04:04] Audrey: Ok now I saw your house at the back, where you have guests, there are little holes in the bamboo. Is that bamboo treated?

Putra: Yes, yes.

[04:18] Audrey: With borax?

Putra: With borax also.

[04:23] Audrey: How come it is attacked by termites?

Putra: But this is the last because that time it is not so, like normally one month you can use. But only two days for that one.

[04:39] Audrey: Ok so you have to put it in borax for one month.

Putra: Yes.

[04:42] Audrey: And you left it 2 days?

Putra: Yes.

[04:44] Audrey: Ok so not long enough?

Putra: No, not long, only two days because, you know, I need a lot more material for that.

[04:55] Audrey: Why do you think people in Bali don't use much bamboo for now?

Putra: For their houses? For those persons it is like very special, they are interested by design from outside. They imagine like: "Oh, I want a house like a concrete like this, like this, like a luxury villa".

[05:23] Audrey: Do you think that they think that bamboo is for the Poor?

Putra: Uh uh.

[05:29] Audrey: And they want luxury and they think luxury is concrete.

Putra: Yes. They don't think that with bamboo you can look nice with bamboo also. The simple, if you look natural is wood. Wood, can you imagine? Wood, until grow up, you need 100 years. With bamboo only 7 years. It's more faster with bamboo.

[06:01] Audrey: How long has your house been here? The bamboo house and the lodge.

Putra: 6 month.

[06:09] Audrey: Ok so it is very new? Only 6 months ago?

Putra: No, no, I built 3 years ago but it took 6 months.

[06:17] Audrey: Ok to build the building then.

Putra: Yes.

[06:19] Audrey: If you had to build a new house here or maybe, I don't know, if you had some more land, would you still use bamboo?

Putra: Yes I already have imagined also. I want to make a house like a plane. Like an airplane houses. Yes, airplane. I made a model there already.

[06:37] Audrey: I think I saw it at the back.

Putra: That's my dream, the second one.

[06:43] Audrey: Can you talk to me more about it?

Putra: Yes because I want to have a different style. If I like boats, I've already made it before, like a restaurant. Now like an airplane, looking nice, easier for the marketing, for the promotion also, to get the customers.

[07:05] Audrey: What do you neighbours think of the house? Your neighbours about your house in bamboo?

Putra: If they're a Western, they say: "wow. Amazing." Like that. Like Balinese it's normal.

[07:24] Audrey: Ok so they just think it is normal?

Putra: Yes this is normal for Balinese.

[07:28] Audrey: But the houses are round or not made of bamboo?

Putra: No, I'm the only one in the village.

[07:38] Audrey: When they see your house do they say they want the same?

Putra: If they are from the centre, they say "it's back to natural", they are sitting here until so many hours, but in this village there are just not interested. If they are from the centre, yes.

[08:02] Audrey: Why are they not interested?

Putra: I don't know because they lost the Patience, because you know like bamboo, bamboo is normal in Bali, it's Bamboo. For me it is different because I work in concrete I work in bamboo, I worked with John Hardy a long time ago. For that I know all houses and I know it is very good for making the houses. When I know I want to build

all my houses by bamboo. It is not all finished yet, if you're finished building all using by bamboo before...

[Putra's mother brings us coffee]

[08:38] Audrey: Thank you very much. Wait. Do you think is cheapest: brick, concrete or bamboo?

Putra: Bamboo.

[08:53] Audrey: And do you think it's also cheaper than wood?

Putra: Yes, more cheaper if the company... Like Asali, you know, it's very expensive.

[09:05] Audrey: Is very expensive, Asali, you think?

Putra: Yes, because... Are you recording?

[09:11] Audrey: Yes but it's ok I'm not going to tell Asali...

Putra: I have one project in Gili, I put my price: 3 million per meter square is a normal price. And in Asali, they put more high than me, two times or four times.

[09:32] Audrey: So did they put 9 million per meter square?

Putra: More. And they get the building. Because it's a big company, I don't know... Yes it's very expensive. Do you know the stuff on Gili air?

[09:53] Audrey: Yes, I've seen the project on Gili Air.

Putra: Before I meet with the owner. I gave him the solution, you must make the house like this, like this. 10 times I meeting with him.

[10:06] Audrey: And how expensive is concrete construction per meter square here?

Putra: For the concrete here, if you want like a luxury villa it is very expensive.

[10:16] Audrey: And for a normal Balinese house?

Putra: For a normal Balinese, 5 million per meter square. For the bamboo if it's me I can make 1 million per metre square. It is more cheap you know because for the material it is not so expensive, if you can do the treatments that by yourself, If you buy it already. For the bamboo, only this bamboo, if you buy it to the farmer it is very cheap, it's cheap, not the same, like 55.

[10:49] Audrey: And to treat it, to treat the bamboo, how expensive is it?

Putra: Enough for the treatment you just buy borax only 1 million.

[11:01] Audrey: How much bamboo can you treat with that?

Putra: Huh... Because you know you put only one time, and then put again put again. It is not lost, it's not the treatment. If you're good for the pole also. You just protect the water.

[11:24] Audrey: How much bamboo can you put in the same water?

Putra: More than 2000.

[11:28] Audrey: 2000 poles?

Putra: Yes. A lot of poles.

[11:35] Audrey: Do you think of anything that would bring people to use bamboo or that could stop them from using bamboo?

Putra: I can bring them.

[11:47] Audrey: You? Ha ha. No but I mean maybe... Do Mindsets need to change? Or maybe more companies should use bamboo? Do you think of anything that could help? Or do you think of something that would stop people from using it? Maybe if there is an earthquake and bamboo houses fall?

Putra: It never Falls because they follow the gravity also. They never falling down if the construction is light. If it's not, if you use like a bamboo... Until now, I did hear like a bamboo house fall. It's not going to fall.

[12:31] Audrey: Ok, thank you very much.

Putra: You're welcome !

H. TRANSCRIPT 5 – CONFERENCE BY ELORA HARDY ON THE 16/04/19, IN SEMINYAK, BALI, INDONESIA

[Conference – transcript of the parts relevant for the study]

[07:15] Maybe beauty is essential, maybe there's something critical in there. (...)

[07:25] It's just a show off but it creates possibilities. And what I've seen it create is a promise, it's a promise to the kids of a bountiful future.

[07:47] A team of artisans, architects, designers, I found myself leading a team of 130 people and as it turned out it was beyond that, a whole new industry was in motion. You don't sell reliably treated bamboo at the hardware store. So we have had to harvest trees and process them before we could even get to building. Sometimes we look out there to see what other bamboo we can buy for a project, but we cannot necessarily count on it. At the moment we still have to treat our raw material to be sure. And they don't teach how to design with bamboo in architecture school, so it's our process of learning it together and teaching each other. And it has been this adventure as a team together, we have had just enough skills and flexibility and grip to

make it happen over 80 structures in 8 years most of them here in Bali, but also around the world. (...)

[09:26] In the absence of a proper and true vocabulary of bamboo architecture or engineering, over the past 15 years, this team who is still my team now, has really had to invent our own rules and hold ourselves accountable and design our own process. (...)

[10:02] We'll design the house very often to fit in these existing contours of the land, no bulldozers, no level. These are the foundations of 6 storey house. We build light on the land whenever possible, respecting it.

[10:18] These long legs will flex shift long before they crack under the pressure of any earthquake. (...)

[12:46] The question that we are really chasing is how do we as humans with our soft skin and vulnerabilities, how can we add comfortable places for ourselves to be in the beauty of nature without harming it. So often we do this offensively, often we impose an idea from another place into the nature that we chose which is a paradox because we often chose the site because we love it. (...)

[16:08] And of course we also all need shelter. But what it seems is that somewhere along the way we have the default come to shut ourselves off. When we could expect to adjust the exact temperature in the room with a thermostat on the wall or a remote control, that convenience is really seductive and it feels good. It is a feeling of power and control and in some situations, some climates, it is absolutely necessary I can't deny that. But when it becomes a way of thinking, when it becomes the automatic, this defensive protectiveness, it's at the point where it is at the expense of the future, we all are seeing that. But not only that, it's at the expense of your experience of the present moment.

[17:05] These are the kids at Sharma Springs, it is the morning, there is the mist, they feel it on their skin. The light is beginning to play through the space. There's some breeze, there is something about what the air around us can give us if we let it in that can add so much. But to step out of the protective shell, to get out of the defensive mode, you kind of need to know that you are going to get more back than the control that you're giving up. So it's about moments of light, it's about moments of feeling. Humans and other natural thing, we aren't made of so many right angles and straight lines. What are we surrounding ourselves with? (...)

[18:04] (our clients) have a hunger for connection that is much greater than their concern about a few ants wandering by. And what they get back, what makes it worth it, what I see is the sense of joy sometimes even the sense of wonder. And it comes down back to the little things: a sense of texture and the energy that you get from encountering textured surfaces. The first step of your day onto soft warm bamboo wood under bare feet. The first step of a life, what does that do to you? How does that wire your brain?

[19:28] And then it is also very useful because it is lightweight, with the tensile strength of steel and the compressive strength of concrete. It is all so long: up to 18 m of usable length. There is a lot of possibilities in 18 meters. There's a lot of floors.

[19:48] And seriously from simple huts to elaborate bridges, like this one in Java, bamboo has already been in quite sophisticated uses across the tropical regions of the world, for literally tens of thousands of years. We did not discover this plant. There are islands, even continents, that were likely first reached by bamboo rafts. But until recently it was almost impossible to reliably protect it insects. Even today there are a lot of bamboo building on this island that have little holes in them. The powder hole beetle is getting in there and eating them up. And for that reason, just about everything that was ever built in history from bamboo, just about everything is gone. And that is because unprotected bamboo weathers, untreated bamboo gets eaten to dust. But more importantly, that is why most people in the world, especially in tropical regions where bamboo grows, feel that you couldn't be poor enough or ignorant enough to actually consider living in a bamboo House. We started to change their mind. This go back to having learnt how to treat our bamboo with a natural salt called Borax first introduced to us by Linda Garland, which allows us to build permanent structures that will last as long as a well-cared-for wooden house could. And the problem is, there are several problems, but the main one is that we are designing for curving, tapering, hollow poles, no two poles alike, no straight lines, no "two by four"s here, and sometimes I confess I dream of "two by four"s plywood. Those of you who are architects will be digesting this and getting this: there is no straight lines ! And none of us can say that they are experts in bamboo, there is so much to learn. There are people in my team have more experience in this than anyone in the world and we are humble all the time. All that what we can do is try to grow quickly like bamboo. We strive to be flexible, we talked about this a lot. How can we be flexible enough to do bamboo justice? Some of our architects have actually said that they feel like they need to unlearn a lot of what they were trained in in order to be able to get their heads around doing what we do and doing it well, and doing it differently, finding the right ways to do it for this material. So we question constantly. (...)

[29:46] So when Autodesk showed up, a few years ago, wanting to free these fans and study our handmade structures. They wanted to test the machines that they'd been developing on our buildings. I have to say I was a little apprehensive at first. All these equipment sizing up and measuring our handmade homes. But I couldn't deny how interesting it was that these, that the technology that we couldn't quite bend to our needs, that they would want to come and study us. So they used cutting edge technology to data capture what they called our rugged terrain and they didn't mean the land they meant the building. (...) They also scanned the scale model and they compared it. (...) But that attention to detail was not lost on the final structure, this blew them away, even though it was replicated on site truly by hand. To me that was a given, the whole point. We had to take the structural model and then build it as closely

as possible. It was interesting because these guys, who created the cutting edge technologies which are opening up so many possibilities in design, very often driving design in new directions, I was so excited to hear them say that we had influenced them that we had inspired them to honour craftsmanship and tradition, and to think about bringing technologies that could support and not always drive design.

[31:03] So what is clear is that change is inevitable, our impact on the world is inevitable. We see it all around us all the time. But is it possible to make that impact positive so that human presence could add value to how we live with nature as a part of nature. (...)

[32:12] And what we see coming out of it all is that they are a lot of things we need in the world. Beyond beautiful fanciful structures, what we are really going to need to do is to house millions of people and this is not the way to do that, I'm not pretending that it is, but I hope that it is shining a light and opening the box, opening Pandora's Box, on a way to begin, a way to think about it. When we are going to need to redesign how we make buildings and objects and medicines and so many things and we are going to have to do it with materials that won't run out on us, and even more so with ways of thinking that are new and flexible and future proof. So I wonder what other materials are out there that are sustainable, regenerative the way that bamboo is, or can be reused indefinitely or be grown effortlessly. The design challenge of that is fantastic. The design process are thinking about what you're working with and how it can be valuable in different ways over periods of time without downgrading. There is so much that can happen from the scale of a human mind and design capabilities. And as the happens what I feel we need to do is to start aspiring to scarcity and stop stressing about scarcity but rather reach in for bounty and seeking out abundance. We can build a building out of poles that didn't exist four years ago that grew from sunlight and rainwater. If we can do that, there's a lot that's possible. We need to seek out abundance and inspire aspiration in this thing that we are calling sustainability. (...)

[Question 1: Does bamboo need a special treatment or maintenance to last longer here in Bali?]

You can think about it as being pretty much equivalent to a wooden house. to be designed properly to begin with to protect it from the insects and then it's designed smartly to protect it from the UV and that the engineering is all done well, you can expect a properly built bamboo house to last as long as a properly built wooden house. And they are wooden houses that are hundreds of years. we haven't had the chance to prove this in bamboo you haven't had decades or centuries yet. But it will last as well as wood when planned for. You also ask about maintenance: the maintenance is also quite similar to wood. Every few years you need to recoat it and the coating that were using at the moment are coatings very similar to what we use on wood. In the future I see that all expanding and enhancing quite dramatically because I believe the innovation of coatings will continue to accelerate and will be able to link up and use really durable long lasting coating on bamboo that we can count on. But right now

you can really only count on it for a couple of years. there's a lot of interior cosmetics for the finishing that can be done but the key is to recoat the exposed zones every few years. And in the future, those innovations and technology and different types of coatings will allow us to design very different shapes. Right now we have the style overhanging roofs, and that's a lovely stylistic thing, but it is also a practical protecting thing. That way, the possibilities will open up when we don't have to protect it when we can protected with a coating instead of a roof.

[Question 2: In your lifetime, have you seen a change in the way the see and accept the material?]

Well it's definitely being accepted as a business opportunity there are a lot of teams out there working with bamboo and taking it very seriously in that way, so I definitely see that. They don't see it like people building their homes and villages out of if again, they are still remembering their grandmother's home that wasn't able to last as long because it wasn't properly treated. but I also see a future for that. It just takes some time and it also takes cost efficiencies, which hasn't happened yet. And it takes design innovation to be thinking in that direction so there's a lot possible there.

[Question 3: As a designer and an architect, if you had the power to change one thing in Bali, what would it be?]

Oddly, because we are working very much outside of any system of regulations, it disappoints me that there isn't a bigger system in place that's guiding what's allowed to be built. Because there's so many irresponsible decisions. When we have an earthquake, there will be so much tragedy, because there hasn't been a way of, from what I understand happens on in certain parts of the world, of you know requiring people to have, builder to have smart choices and integrity around the material that they're using and the structural techniques. And as much as it's amazing to have this space to innovate that we have because no one is stopping us and no one is guiding us from governmental perspective in terms of like regulating how we are doing our engineering, that all on us. We have to be accountable as designers and architects and figure that out for ourselves and think about engineering and be responsible for our clients. In other parts of the world that is being really regarded by a bigger body, and I think that is what it would take for Bali to be like: "Oh, you just can't, it doesn't matter how much you'd pay me, you just can't there, in that situation you cannot build with that material" and just putting some brakes on it, because it's a really random thing and it is hard to watch.

[Questions 4 and 5 concern other matter, bamboo in specific fields, not relevant for this master thesis]

[Question 6: I want to know how you engineer the bamboo? Because with conventional material, the structural engineer can check if the material's strong enough]

Well similarly you need an engineer properties of the material they need to do some tests to get familiar with the strengths to be counting on. But because the material is so variable, they basically have to assume that every pole in the building behaves like the weakest pole that they've ever measured, and then they count for that. And so I suspect that when people look in time at our buildings, they will see that they are outrageously over engineered but I am very happy that they to do that in the meantime. It is all based on the same process of measuring and qualifying and you have to take into account the flexion, there is a lot of flexibility. [With bamboo, you don't have standard as with steel or concrete] No, they have to observe and measure, they have to research in order to be able to consider engineering for bamboo. So people that we work with have to have that background and then also they have to recognize her unique and different the pole is, and in some cases I've heard bamboo... I've heard engineers speak in the most inspired ways about the properties of the

material, the shape and the way structural form is designed really tends to impress engineers when they come to study it. It is often compared to carbon fibres. In certain ways you can compress like concrete, you can have tensile strength as in steel, but overall there something apparently about carbon fibres that is the most similar. What is the most I know but they get really excited and politic about it.

[Question 7: Considering the material and the labour, it seems that this might take more labour than an average concrete building. What is this like from a cost analysis perspective. Is it more expensive than to use this materials, considering the labour and the costs of raw materials or more expensive?]

It is more expensive. We are able to usually charge something similar to what it would be in another material. There is a little bit of balancing that happens because the raw material is very affordable but it has to go through so many hands in order to be properly treated and dried and prepared and crafted that by the end of it, we've only been able to succeed because we've been able to add value in the design sense and people appreciate it, it catches just people's hearts and our clients has embraced it as a luxury product. But the price is actually higher for building a high end conventional villa versus a bamboo villa although we've been able to keep it parallel. But it is much much more work. There're many more design hours and it is a lot of craftsmanship hours.

Another question was how we were planning to make it accessible for a lot of people. Well, I don't know. Is that my job? Maybe it is. I'd love to be involved in that. I'd love it, I'd love to be a part of a movement that'd make bamboo super accessible. Right now my responsibility is to try to take this plant form and this team and the possibilities of where we've taken it and just push that as far as I can. And what I'm proud about that, in the bigger picture, is that this has opened up so many people's minds to accept it or to consider it. And I think it's probably more likely that we'll inspire someone to figure that out, someone who has complementary skills. People ask me that a lot at bamboo U. While people come to bamboo U and ask like: "Wait, how do we make this affordable?" and I'm like: "I don't know, how are you gonna do? Let's figure it out!"

But right now it's like clients, projects, responsibilities, it's like the normal stuff of a business and that's what we're focused on as a team.

I. TRANSCRIPT 6 – IN-DEPTH INTERVIEW OF AYU SIMPANI, ACCOUNTER AT ASALI BALI

[00:03] Audrey: I will ask a couple of questions. You can eat of course. Answer as much as you can in English. If you don't how to say it in English, you can say it in Bahasa Indonesia. I will translate afterwards.

Could you remind us your name? What it your name?

Ayu: Ayu Simpani

[00:28] Audrey: Where do you live?

Ayu: In Gianyar

[00:35] Audrey: How old are you?

Ayu: Sorry?

[00:38] Audrey: How old, your age?

Ayu: 30 years old

[00:46] Audrey: What is your profession? Your job?

Ayu: Accounting

[00:50] Audrey: You work at asali bali, so you work in a bamboo firm?

Ayu: Yes

[00:55] Audrey: How long have you been working there?

Ayu: 2 years

[01:02] Audrey: Could you tell us a bit about your house? Your Home? Your house? Your rumah?

What is it made of? The materials? Materials?

Ayu: My house material from concrete, wood and the roof from tile.

[01:34] Audrey: Do you live alone or with your family?

Ayu: I live alone.

[01:40] Audrey: Do you have a bathroom, a kitchen? How many rooms do you have at home?

Ayu: The number of rooms in my house: four. One... One kitchen and one bathroom.

[02:07] Audrey: What would you say it the most used material in Bali? What it mostly used?

Ayu: The material in Bali the most used is concrete and wood. And "Bata", do you know "Bata"? [Indonesian]

[02:35] Audrey: Ok, I'll look it up after. Why do you think everybody uses concrete? Why? [FTR: Bata = Brick]

Ayu: Because concrete it's more... like... maybe... hum... up for "fiveteen" years... "batahan" ? [Indonesian]

[03:09] Audrey: Is it because it's gonna last a long time?

Ayu: A long time.

[03:14] Audrey: 30 years?

Ayu: 50 years maybe.

[03:23] Audrey: And wood, why would you say they use wood?

Ayu: Because wood is... normally in Bali many people like the material from wood because like you know in Bali build normally from wood.

[03:50] Audrey: Now if you want to build a new construction in your home, for example an extension to your home but with no restriction of budget, what material would you use?

Ayu: Wood and concrete.

[04:20] Audrey: Why would you use those? Why concrete and wood?

Ayu: Because the concrete until 50 years like batahan.

[04:38] Audrey: Ok, not going to move?

Ayu: Yes.

[04:41] Audrey: Now if I ask you about bamboo construction, what comes in mind first? What is the very first thing that you think about?

Ayu: Ok bamboo construction: good, like back to nature, cheap and you know like... earthquake?

[05:10] Audrey: Ok like earthquake resistant or not?

Ayu: Yes earthquake resistant.

[05:19] Audrey: What do you think is the cheapest between concrete, bricks and bamboo construction? What is the cheapest? Do you think bamboo is cheaper than concrete and brick?

Ayu: Yes.

[05:38] Audrey: And wood?

Ayu: Yes cheaper.

[05:39] Audrey: Are you sure?

Ayu: Really sure.

[05:42] Audrey: How long does a bamboo house last? How long is it going to stay?

Ayu: Maybe 20 years.

[05:59] Audrey: Can you think of anything that would keep people to use bamboo? Can you think of any barrier to the use of bamboo? Something stopping people from using bamboo?

Ayu: What?

[06:28] Audrey: Why people don't want to use bamboo?

Ayu: Because not so long lasting.

[06:40] Audrey: Can you think of something that can encourage people to use bamboo? Something that would push people to use bamboo? Making them want to use bamboo?

Ayu: Yes I want to help people to say: ok it's better for the future use bamboo. Ok you plant now and in a few years cut and you can make a bamboo.... like... You can also use for like alangs (alangs?)

[07:41] Audrey: For the walls?

Ayu: Yes.

[07:44] Audrey: Now I'm going to show you some pictures. I want you to choose 3 pictures and comment them. You can say what you like or dislike. You can say you don't like some things.

Ayu: Three...

[08:07] Audrey: 3 photos.

Ayu: I like 3 photos and I don't like 3 photos?

[08:17] Audrey: You can choose 3 and either say what you like or don't like.

Ayu: Ok.

[looks at the pictures, picks one]

I like it.

[continues]

I don't like.

[08:41] Audrey: Ok. This one you like, this one you don't like. Can you choose a third one?

Ayu: Hum... I like this.

[08:54] Audrey: Ok. We'll keep the 3. Now could you tell me what you don't like and what you like about these?

Could you tell me what you like?

Ayu: I like this because this is a good... good building, full of bamboo like hum... it's so nature.

[09:42] Audrey: What do you like about the bamboo in this picture?

Ayu: What do I like? Maybe give me an example?

[09:53] Audrey: How about the colours? Is it the colours that you like? Or maybe something else? The light?

Ayu: Okay. I like this design of the room. (writes the word in Bahasa on transator)

[10:37] Audrey: The shapes, you like the shapes?

Ayu: Yes.

[10:40] Audrey: Do you like it's colours?

Ayu: Yes very much.

[10:43] Audrey: And what do you think of the light?

Ayu: Yes. Good because a lot of light.

[10:51] Audrey: Would you like this for your home?

Ayu: I think so, yes.

[10:58] Audrey: For what part of your home would you like something similar to this?

Ayu: Maybe for my bedroom.

[11:12] Audrey: Ok good. And how about this picture? You said you don't like it.

Ayu: Yes.

[11:17] Audrey: Can you tell me why you don't like it?

Ayu: Because no... not the light. It's not very good for indoor because...

[11:30] Audrey: Because it's very closed? So not much light inside.

Ayu: Yes.

[11:39] Audrey: Ok. This one you don't like. Is there something else about this one?

Ayu: No. only that.

[11:43] Audrey: Ok. Now you said you like this one.

Ayu: Yes.

[11:46] Audrey: What do you like?

Ayu: I like the shape and like it's outdoors, like terbuka [indo. for open] Like back to nature, I like this.

[12:10] Audrey: Would you like this in your home?

Ayu: Yes.

[12:14] Audrey: Ok. For what part of your home would you like it best?

Ayu: For kitchen.

[12:20] Audrey: For your kitchen?

Ayu: Yes.

[12:24] Audrey: Terima kasih Ayu.

Ayu: Sama sama.

[12:31] Audrey: Could you remind us why you said you would use bamboo or wouldn't bamboo for your house? You remember when I ask to build a new extension for your home, you said you'd use concrete and wood. Why didn't you think about bamboo?

Ayu: Because it doesn't last long enough.

[13:10] Audrey: You work at Asali Bali, they say bamboo can last very long.

Ayu: Only until 20 years

[13:22] Audrey: Thierry told me it could last way longer. If bamboo lasts 50 years, would you use it?

Ayu: Yes of course.

[13:44] Audrey: If your neighbours built in bamboo, what would you say?

Ayu: It's good.

[13:57] Audrey: You like everything about bamboo but you think it doesn't last long?

Ayu: Yes.

[14:02] Audrey: Ok. Is there something that you prefer in concrete?

Ayu: Hum?

[14:06] Audrey: Do you think it's prettier?

Ayu: Pretty?

[checks it out on google translate]

Ayu: More concrete than bamboo?

[14:50] Audrey: Do you like more concrete than bamboo?

Ayu: Yes.

[14:55] Audrey: Because it lasts long?

Ayu: Yes.

[14:58] Audrey: But it there something else?

[google translate for the words beautiful, pretty, nice]

Ayu: Yeah. For me, cukup.

[15:50] Audrey: Do you think bamboo is more pretty or concrete or brick?

Ayu: What is pretty?

[15:55] Audrey: Cukup

Ayu: Bamboo cukup

[16:03] Audrey: But if you have to rank these. If you have to put one first one second one third. [takes the images of the materials] Which one is the more beautiful?

Ayu: Brick.

[16:31] Audrey: Second?

Ayu: Bamboo.

[16:40] Audrey: So concrete third. But you still want concrete for your house?

Ayu: Yes but for me is more important that it lasts long. Bamboo is this beautiful building and shapes. But concrete is most longer.

[17:14] Audrey: Ok so we are done for now. Thank you. You can have a drink and order a the food you like. We can wait a little.

J. TRANSCRIPT 7 – COMMENTED WALK OF AYU

[00:03] Audrey: So I'm recording you during the visit. You will be filmed. So we are going to visit and you will be filmed. I'm going to let you visit and you can walk wherever you want to go. I'm not telling you where to go, like you go there you go there... You can just feel free to touch the material in the houses. You can tell me

how you feel, what you like, what you don't like. Of you like something you tell me, if you don't like something you tell me.

In your own house, what would you like to change, to add or to build? New bedroom, new kitchen?

Ayu: Okay I want to change my bedroom and with bamboo material...

[01:26] Audrey: So this is your new bedroom. Let's go in your new bedroom. Imagine this is not there there's a sofa and then we go in, and maybe here's your bed, your office, your cupboard for your clothes. This is your bedroom. What do you like?

Ayu: Okay I like my bedroom. And I like my cupboard, and I like my office...

[02:11] Audrey: Now the place. How do you feel about the construction?

Ayu: I like this construction because it is so natural.

[02:24] Audrey: You can touch!

Ayu: Okay it's uh... I like it. Because this is a natural material and so...

[02:44] Audrey: Sustainable?

Ayu: Yes sustainable, and...

[05:50] Audrey: Do you think it's noisy? [claps on the ground and walls to make some sounds, no echo]

Ayu: No, not too noisy.

[03:04] Audrey: Take a big breath, for the smell. How do you feel?

Ayu: [take a breath] yes it's good, the smell...

[03:15] Audrey: The light?

Ayu: The light, light is good for a bedroom, not too ...

[03:23] Audrey: The air?

Ayu: The air... Good.

[03:30] Audrey: What don't you like?

Ayu: Okay I don't like an office, because the office in the bedroom...

[03:43] Audrey: Ok so ne office there. What else don't you like?

Ayu: I don't like this door.

[03:55] Audrey: Ok, why?

Ayu: Because the door is not so... I want to make like... not mirror, but like this, glass, for light. I need more light maybe. This is enough but more is better.

[04:30] Audrey: Do you like the texture, touching it? Or not? Do you like the touch?

Ayu: Yes I like.

[04:39] Audrey: What would you say to describe it? You can say it in Bahasa

Ayu: What is describe?

[04:50] Audrey: [looks it up on google translate]

Ayu: Ok. For this material, bamboo... [talks in Indonesian]... like back to nature, cheaper and safe because earthquake resistant and good for life.

[05:57] Audrey: Do you feel nice?

Ayu: Yes I promise!

[06:01] Audrey: Now we'll go to the other one. Follow me. Mosquito terrible! So now what happens is that your house, imagine there was an earthquake and your house is destroyed. You don't have a house. But I got you a new house. So now we are going to visit, you can visit your new house and tell me what you like, what you don't like and everything, the smell, the lights, the touch... everything. We're just going to take off the shoes before we visit. Here, let's take off our shoes. Go ahead. Here.

[07:26] Owner of the house: Halo, selamat siang, apa kabar?

[07:34] Audrey: What do you think? What do you like? What don't you like?

Ayu: Okay, I like it! Woooow... I like the interior.

[07:51] Audrey: Is it the colours? Or the shapes, maybe?

Ayu: Yeah... Good!

[08:05] Owner of the house: You can hate it, it's okay!

[08:06] Audrey: I always ask what don't you like?

Ayu: Oh I don't know!

[08:10] Owner of the house: If you don't like it it's okay. I don't mind.

Ayu: [Indonesian] ... Bagus! [FTW: bagus means Nice]

[08:17] Owner's wife: Most people don't like it.

[conversation in Indonesian]

Ayu: I like it!

[08:34] Audrey: If you want to go upstairs, you can.

Ayu: [going upstairs]

[Stairs cracking]

[08:48] Audrey: How do you feel about the stairs?

Ayu: What is this?

[08:57] Audrey: Storage

Ayu: Why is storage here?

[09:01] Audrey: Because we don't use it often.

Ayu: I don't like it because maybe I want storage maybe downstairs.

[09:15] Audrey: Ok. Now do you think it's noisy? Or do you think it's...?

Ayu: Well I like it but I don't like it's because the light.

[09:25] Audrey: Not enough light?

Ayu: Yeah.

[09:28] Audrey: How do you feel about ... [touches the walls and handrail] is that good for you?

Ayu: Yes this is good for me!

[09:38] Audrey: Do you think it's strong? Weak? ... Do you think it's strong?

Ayu: Yes strong. Yes, very strong.

[09:48] Audrey: Do you feel safe? Do you feel comfy? Do you feel hot? Maybe too hot?

Ayu: Too hot, yes. For me this is too hot.

[10:05] Audrey: Would you change your house for this one?

Ayu: Yes!

[10:12] Audrey: Are you sure?

Ayu: Really.

[10:14] Audrey: Are you really sure? Because you can say no you know? I like it when people disagree. You can disagree?

Ayu: Yes! But I like it. I want to change... Only my bedroom not my house.

[10:34] Audrey: Ok that's good to know, we'll come back to this. [going downstairs to the bedroom] You want to have a look? Would you like a bedroom like this one?

Ayu: [whispering] Yes! I like it.

[11:02] Audrey: I'll let you just process it and then I'll come back with a few questions about this. Okay? I will let you time to rest and then a few more questions. Have a last peak if you like.

[11:25] Owner's wife: If you want to see the kitchen, come have a look.

Ayu: [goes in the kitchen]

[11:37] Audrey: Look at the walls, ceilings...

Ayu: [speaks Indonesian= I think bamboo is describing nature. Use bamboo is cheaper, back to nature and I feel nice also good for life.] Bagus!

[11:47] Audrey: Bagus, nice! If you have anything to add? I'll let you go back to the group. I'll take the camera back as we're done with today's visits. Terima kasih Ayu!

K. TRANSCRIPT 8 – INTERVIEW POST COMMENTED WALK OF AYU

[00:03] Audrey: How did you feel during the visit ?

Ayu: I feel happy

[00:13] Audrey: Why?

Ayu: Because back to nature, I see new building house. New experience for me.

[00:31] Audrey: Would you build in bamboo now? You previously said yes but not for all my home. Just for your bedroom. Why is that?

Ayu: Because only me like bamboo.

[00:50] Audrey: What about your family?

Ayu: I don't know. Because my family never come to a place like this place and never see a bamboo house. Maybe if they come to this place and see the bamboo house, maybe yes.

[01:14] Audrey: Ok, maybe they'd like that but for now they don't?

Ayu: No.

[01:20] Audrey: Why do you think they don't like bamboo?

Ayu: Because not long lasting.

[01:34] Audrey: If one of your neighbours built in bamboo, what would you tell them?

Ayu: I'd want to tell them "Oh this is bamboo! It's really good for you. A good resistance. Cheaper than concrete and steel or what."

[01:58] Audrey: How long do you think a bamboo construction lasts? How long in time does the bamboo house last, does a bamboo house can stay?

Ayu: How long?

[02:10] Audrey: How long in time, how many years will the house be there?

Ayu: Like 20 years

[02:23] Audrey: Ok 20 years. Did you change your mind about bamboo during the visit?

Ayu: Yes.

[02:30] Audrey: Ok.

Ayu: I changed my mind.

[02:33] Audrey: During this visit?

Ayu: Yes

[02:34] Audrey: Ok. Why did you change your mind? What made you change your mind?

Ayu: Because it's bamboo, it's so beautiful, it's natural.

[02:47] Audrey: That wasn't the first time you saw bamboo though?

Ayu: Yes but because I only saw simple simple building but now I see a beautiful building.

[03:03] Audrey: This is a home. Is this the first time you see a bamboo house like this one?

Ayu: Yes this is first time.

[03:11] Audrey: But you have seen a lot of building in bamboo already with Olivier and Antoine at work?

Ayu: Only seen, not like now. Only like also more than now. Ok Only seen like this, like this, like this, like this, fast nananah. Not so: "okay what do you feel about this?" not like that. Only: "ok we are building a building like this and nananah" Ok. Not so "ok, what you feel about this building? If you had this building how would you feel?" and that made me change my mind.

[04:02] Audrey: Can you think about something that would stop people from constructing in bamboo? Why wouldn't people want to build in bamboo?

Ayu: Not long lasting and maintenance is too expensive because hum ok for 5 years you have to treatment because of you not treatment you'll have cracks and termites.

[04:45] Audrey: How much do you think it costs, a bamboo house? Price?

Ayu: 2 million rupiahs and half, 2 million rupiahs until 2.5 million rupiahs per meter square.

[05:08] Audrey: To sum up, is there anything you want to add? Is there something more you want to say?

Ayu: No.

[05:15] Audrey: No you're good?

Ayu: Yes. (giggles)

[05:19] Audrey: Ok. Terima kasih Ayu.

L. TRANSCRIPT 9 – IN-DEPTH INTERVIEW OF ADE PARMITHA, STUDENT

[00:04] Audrey: Ok, so now I am recording you. Could you repeat your name and where do you live?

Ade: Yes my name is Ade Parmitha. I live at Denpasar.

[00:15] Audrey: How old are you?

Ade: I'm 21 years old.

[00:20] Audrey: Are you still a student?

Ade: Yes, I am a student.

[00:22] Audrey: What do you study?

Ade: I study at the University of Mahasaraswati Denpasar, major at the English literature.

[00:30] Audrey: Now, could you tell me about your home, your house? I know you brought pictures.

Ade: Yes.

[00:36] Audrey: Can I see them?

Ade: Alright here they are.

[00:53] Audrey: Okay good, terima kasih.

Ade: Sama sama.

[00:58] Audrey: So this is your home.

Ade: Yes.

[01:01] Audrey: Where is this?

Ade: This is what I call Bale Danga. it's in the north of the house. It is made of bata and a little bit of concrete.

[01:22] Audrey: Concrete and tiles, and a little bit of bricks? is this bricks? Just in front of the concrete?

Ade: Yes just in front of the concrete. Now this is wooden, for the doors. Now this is my nephew's house, like in front of my house. Here's my room.

[01:48] Audrey: Your bedroom?

Ade: Yes my bedroom, from concrete also and wooden. Now this is the front of my living room, the best feeling is from bamboo, so this is good.

[02:10] Audrey: So this is wood, and then this is bamboo woven?

Ade: Yes. this is Bale Danga, and this is like my Terrace, my room terrace. and this is very close to the living room.

[02:29] Audrey: So is the living room inside?

Ade: Yes.

[02:32] Audrey: Do you spend a lot of time on the porch?

Ade: Yes, like on the Terrace and in the Bale Daging with my family. This is the Sanggah Kemulan. it is the temple in the house of Balinese people. in the second floor of my house. this is 1 and then this went in front of my house.

[02:56] Audrey: So what is there upstairs? what do you do?

Ade: Prayers. Like prayers yes.

[03:08] Audrey: Ok good, thanks. And how many people live with you there?

Ade: Five. Me, my father, my mother and two of my sisters.

[03:23] Audrey: Ok, nice, very good. You already told us what your house is made of. Now what would you say is the good sides, like the pros and cons of the materials in your house? What do you think is good with those materials?

Ade: What is good is that it is simple, and et cetera. It is cheaper, like not expensive save to spend money. Not like the bata [FTR. bata = bricks], the wooden.

The not good is that it is mouldy in my house. Mouldy if it's like the rainy season, the ceiling is not good for this rainy and like leaking and it becomes like mouldy also too. But the good is like the long term.

[04:30] Audrey: It takes up the water and it becomes mouldy inside the house? So that is not good?

Ade: No not good. like that mouldy and all.

[04:47] Audrey: So if in your home if she were to build a new construction maybe a completely new home, or maybe a new part for the home, what would it be? the new bedroom? a new living room?

Ade: I'm afraid it would get mouldy again but I would choose concrete also.

[05:13] Audrey: Ok, so you would choose concrete?

Ade: And maybe wooden. but the good one, Jati [FTR. Jati = Teak]. I don't know how the bamboo is, if it's good or not. Because in Denpasar, in my location it is mouldy and wet. Things in my house, I don't know what, if wooden in my house is good or not. But it's mouldy.

[05:52] Audrey: So he would rather have concrete. But what would it be for? What do you think a new part of your home would be? Would you like a new bedroom or a new kitchen?

Ade: Yeah, a new kitchen and a new living room. because you know in the rainy season it is always leaking. so I don't know why my father keeps the ceiling with the

bamboo because usually the leaking is always disturbing us and I can't... because in the other picture inside my bedroom it is already concrete.

[06:36] Audrey: So now I am going to talk to you about bamboo construction, we are now really going to talk about bamboo. Now what is the first thing that you think about when you hear and you think of bamboo construction?

Ade: Maybe comfortable but past, the bamboo... local products for Balinese old people, maybe comfortable and comfy.

[07:05] Audrey: Would you build in bamboo? Maybe in other conditions, maybe not in your house, but somewhere else if you moved out? Would you build in bamboo?

Ade: Yes of course because it is like in my family and maybe bamboo is cheaper than concrete. I don't know about the long terms. But maybe for villager people it's good, like here it is good for bamboo but I don't know for Denpasar because it's all the millennials, not too much possible with the bamboo and the wooden.

[07:50] Audrey: And if in Denpasar you chose to build a bamboo House what do you think your neighbours would say?

Ade: Maybe unique and they would maybe ask me: is it good for the long terms? Because in my town in Denpasar, it is hot and I don't know if the bamboo is good for the build in Denpasar. Because it's very hot and if we have the bamboo we also have the air conditioner inside the room.

[08:28] Audrey: Do you have air-con at home?

Ade: No. because the electricity is very expensive. we just have the fans.

[08:46] Audrey: What would you say is the cheapest between concrete brick and bamboo? I think I have picture but we can do without. Could you rank bamboo construction for structure, concrete or brick? What would you say is the most expensive and what would you say is the cheapest?

Ade: What is Brick?

[09:36] Audrey: Brick is this. [Audrey finds the picture of the brick wall]

Ade: Oh ok.

[09:46] Audrey: This is concrete, this is brick, this is bamboo. Could you put cheapest here and most expensive here?

Ade: Hu this is cheapest. And then this one in the middle. and then...

[10:00] Audrey: ...and then concrete more expensive ok. Ok so I repeat for the record: so bamboo cheapest, then brick and most expensive is concrete. Now, how long would you say a bamboo construction would last, in your opinion?

Ade: Maybe 2 years.

[10:25] Audrey: Ok, 2 years?

Ade: I don't know! [both jiggle]

[10:31] Audrey: Okay, that's not long. But it's in your point of view, so that's just what I asked. No problem! Can you think of some barriers that would stop people from building with bamboo?

Ade: No because maybe it is good for construction the bamboo from like restaurants or for the furniture maybe, like wooden thing for example from bamboo a chair is ok. So for furniture. But I don't know for the construction because if we build by bamboo, I don't know the long terms.

[11:15] Audrey: Ok. Now I'm going to show you some pictures, you can choose three and you can tell me why. You can choose if because you like it or because you don't like it. So you choose three pictures and you comment them I like this because of that, I don't like this because and tell me why.

Ade: [looks at the pictures]

[11:58] Audrey: Do you want to choose that one?

Ade: Yes. It is good because it has two floors and I love this... How do you say?

[12:12] Audrey: Alang-Alang.

Ade: Yes, the alang-alang for...

[12:016] Audrey: For the roof?

Ade: Yes for the roof.

[12:32] Audrey: Is there something else you like?

Ade: The interior, and like maybe from the outside. The inside is very good, it's comfy maybe for a house. but maybe in the village it is good but not in the city.

[12:53] Audrey: So you like it? Would you like to live in it?

Ade: Yes of course.

[12:58] Audrey: But maybe not in Denpasar? Maybe more in the village...

Ade: No! Maybe I would in my hometown in Gianyar. This is good! In front of the household.

[13:11] Audrey: So this is good. Now can you choose another picture?

Ade: This is also good.

[13:22] Audrey: Ok.

Ade: To meet with my family maybe for the relaxing. So you put it maybe near, in front of the house.

[13:44] Audrey: Do you think bamboo there is a good solution?

Ade: Yeah because I have seen this like Bali bamboo in my hometown. This is a very Common thing. In the afternoon if you want to take a nap, over there it is very nice.

[14:02] Audrey: Better in bamboo or concrete or wood?

Ade: Bamboo is better for this, for the relaxation, for spending some time over there.

[14:16] Audrey: So what is it that you like? Do you like the colour, or is it the sh...?

Ade: I like the shape. And this is maybe it is strong enough for maybe 4 or 5 people. So this one.

[14:41] Audrey: Now if you want to choose one that you don't like, you can also...

Ade: Maybe this one, I don't like it. What is it? Is it a house?

[14:53] Audrey: Yes, it is a house.

Ade: I don't like it because of the roof, and this is not too... maybe... maybe the air will come to inside.

[15:15] Audrey: I think the house is not finished, it still has to have a roof, and then here we have to put a proper window. But it is more like the space. Do you think it could be nice or could be bad?

Ade: Maybe it could be bad, I don't know. It's too... I don't like... I don't know how to say it. It's too much wooden, the interior I don't know, but from outside I like this one better than this one.

[16:12] Audrey: Is there another picture you want to talk about?

Ade: Maybe just this one, with the living room. It is good because I like the sofa the table. It's just that in my hometown many years ago when we changed the sofa from the latex for another one, my grandfather bought this bamboo for the sofa and it was very comfy.

[16:49] Audrey: And what about the rest of the space, do you like the colours?

Ade: The colours are very natural, it's very good also the interior. The stairs also. I think it's also very good, it is very tidy.

[17:20] Audrey: If there is one what more you want to talk about you can.

Ade: No it's enough.

[17:27] Audrey: Ok now can you remind me, for you, the pros and cons of bamboo construction? The advantages and the disadvantages, can you remind me?

Ade: For the bamboo the cons is... maybe environment friendly and cheaper, and supports the local craftsmanship from Bali. False is the long-term maybe. I don't know how many years the bamboo is good for the house. But maybe the bamboo is good when they build until they are finished to minimize the broke.

[18:32] Audrey: Well thank you, this is over. Thank you for answering and we will soon go to visit.

M. TRANSCRIPT 10 – COMMENTED WALK OF ADE

[00:07] Audrey: So I'm going to let you walk around and you'll be the one deciding where you go. I won't be guiding you this is a free visit. This one is really short and then there will be another one there. I asked you to just walk around and tell me are you feeling what you think about the space. The cameras are already there, I'm recording you. So when we were talking earlier, I was asking you what you want for your house, a new kitchen maybe or a new bedroom... So just imagine you're building an extension to your home and the work is done the construction is there. And we're going to go you're going to discover what do you want it to be ? A new kitchen?

Ade: Yes!

[01:07] Audrey: Ok so this is your new kitchen. Imagine that there is a sink, and everything you need even though right now it is not a kitchen but you can imagine it being a kitchen. So here the work is done here is your new kitchen. You can just visit it and comment.

Ade: Oh this is good is there a lamp?

[01:34] Audrey: I don't think so. Imagine there's a lamp, there's definitely a lamp in your kitchen!

Ade: This is good.

[01:46] Audrey: Where do you want to put your stove and fridge?

Ade: I want to put my stuff near this window. It is good for the air. Maybe they think like they're like this and the place with the plates right there and maybe some table for cutting the vegetable could go over there would it be ok to put some storage.

[02:17] Audrey: Yes, of course storage!

Ade: You know because Balinese have a lot of stuff maybe plates and things to put in the storage.

[02:33] Audrey: Ok so now what do you think of the place, of the construction?

Ade: It is good it is not really small I think it is enough for me to...

[02:50] Audrey: To have your kitchen?

Ade: Yes my kitchen.

[02:54] Audrey: And now what do you think about the materials?

Ade: It is good, this is not concrete?

[03:04] Audrey: No.

Ade: Only wood and bamboo?

[03:07] Audrey: No, so this is bamboo, and this is mud, you know like earth you put it and then you let it dry.

Ade: Oh I thought this was wooden. It is good, it is nice.

[03:24] Audrey: And what do you think of the atmosphere? Do you feel good?

Ade: Good because the window is on every wall, and the upstairs is good... I mean the roof. You know for the air circulation, it is good.

[03:49] Audrey: And what do you think of maybe the smell or do you think there is a smell?

Ade: No!

[03:56] Audrey: Ok so what do you think of the feeling if you touch it? Do you like it?

Ade: I don't know this is like a little dusty but it's still nice.

[04:07] Audrey: And the bamboo? How do you feel with it?

Ade: This is strong enough. This is only bamboo or is it has the iron inside?

[04:17] Audrey: No this is just bamboo.

Ade: Oh just bamboo! It's good! [knocks on the columns] So this is strong enough for me. Yes, it is good overall I really like it. It is the first time I saw this.

[04:42] Audrey: Now, we are going to go to the other place. I always take off my shoes for the other place we can take off our shoes so this is the owner's house and so now the scenario is that OK they have been a catastrophe, and you lost your home but you have a new home. Ok? You don't really know what it's made of, you don't know how it is but we are going to visit it and you are going to tell me how you feel about it. So that was your kitchen, but then it got destroyed and now you've got a new home you can go. Ok, there are some people in your home but that's ok. So, it is the same, I'm going to let you just visit the way you want. And you can just comment like the same way you did for the first building.

Ade: [goes in and stops] Wow. Good.

[06:06] Audrey: Do you like it?

Ade: Is this a sofa?

[06:09] Audrey: Yes, this is like the living room, where's the kitchen.

Ade: Waw, this is surprising. It's good. and it smells like... nice.

Owner's wife: It smells like vinegar.

Ade: Yes vinegar. It's looking good.

[06:41] Audrey: Now if you want to touch the bamboo go ahead. Do you want to go up?

Ade: Is this strong enough for me?

[06:52] Audrey: Just go up and find out!

[stairs cracking]

Ade: I'm a little scared. So this is all of bamboo, no iron maybe inside?

[07:13] Audrey: Yes, no!

Ade: Well it is good. How long this house has made?

[07:25] Audrey: This is your house. Imagine, it is not new you'll found out afterwards. For now just imagine this is your house. Do you like it how do you feel?

Ade: I feel like I am in my hometown it is really good, natural and unique, it is very comfy. Is this a bedroom?

[07:52] Audrey: Yes is the friends' bedroom, there is another bedroom down there. So there is two bedrooms.

Ade: This is good too.

[08:05] Audrey: How do you feel about the sounds maybe?

Ade: The sounds?

[08:11] Audrey: I mean is it not too noisy?

Ade: No, this is good. And I feel comfy in this building, because of all of this bamboo. Now about maybe concrete and the expensive... This is nice!

[08:38] Audrey: So do you feel like it's cheap?

Ade: But still luxury I think.

[08:43] Audrey: Ok, good, it is nice.

Ade: I mean it is good.

[08:47] Audrey: Do you like the touch of it because I noticed you're touching it a lot.

Ade: Yeah because it is the first time I saw the bamboo very big like that and I think inside the bamboo it is iron then...

[09:02] Audrey: You do this [knocking on the bamboo].

Ade: Yes, this is bamboo, really bamboo! Wow, it is good. And like this one, it is like the ceiling in my house, like we talked before... It's alang alang.

[09:16] Audrey: So here, you can see it on the roof and it doesn't leak.

Ade: And it doesn't leak? It's good. And outside it is hot weather but now it's not too hot, it is really good. Maybe in the rain season, it's less good smell, maybe, from the roof and from the bamboo.

[09:57] Audrey: There's the other bedroom, we might not want to go there for intimacy.

Owner: you can go see the bedroom, you're not going to sleep upstairs.

[10:15] Audrey: So here's her new bedroom and your bathroom.

Ade: Oh wow outdoor bathroom, this is my favourite. I imagined that I have that in my house in Denpasar, it's not ok in Denpasar because outside is very hot, and there's a lot of people around me and they could see me. But in my hometown it's ok. It's good. The atmosphere from outside is good. Is this stone?

[11:02] Audrey: Yes. Now, I'll let you take a last walk around, an interview do one last time later, I will let you process it and then I'll come back for some more questions. Let me know if you have any question, ...

[Audrey talking to the owner] She was just asking before how long ago the house was built?

Owner : 10 years ago.

Ade: 10 years [loudly, looking surprised]? Wow. can't imagine it! The bamboo is this some kind of specific bamboo?

Owner: It's treated with borax acid.

[Ade and the owner having a discussion in Indonesian:

Owner : All of this bamboo was treatment before we use for house. Since they not affected by sun shine, and the roof replaced at least 5 years once, they will good enough.

Ade : Are this bamboo getting mouldy?

Owner : No , aren't. But when rainy, mouldy is impact for our clothes. They become mouldy and have bed smell.

Ade : I was think, that house with bamboo only survive at 2 years. But in real life, they can be longer than in my opinion before.

Owner : Yes, the challenges is only at roof, because they are from "Alang-alang" and must be clean from dust.]

[12:41] Audrey: She was worried in the interview before, she told me got bamboo could only last 5 years, is that what you said?

Ade: 2 years! I think that before because rayap [indo. for termites]. Just termites because if it's not treated.

Owner: Yes, you can get beetles. [talking in Indonesian again]

Ade: Yes, this is good it's very surprising that it's 10 years, wow!

[13:33] Audrey: And it might be longer, it's in good shape. I mean, really good shape. Maybe a lifetime.

Owner: I hope longer.

Owner's wife: yes, it must!

[13:45] Audrey: Thank you have the next visit and then I'll ask you some more questions, there you go. Terima kasih banyak.

Ade: Sama sama. I will tell my father later about this!

N. TRANSCRIPT 11 – INTERVIEW POST COMMENTED WALK OF ADE

[00:01] Audrey: Aren't you too tired?

Ade: No, I'm very excited because it's the first time I visit a place like this. Because most of the bamboo, for example in Bali, very expensive to visit. Very expensive.

[00:21] Audrey: How did you feel during the visit?

Ade: Very excited, wonderful and comfy.

[00:32] Audrey: Would you build in bamboo?

Ade: Yes, I think in my hometown I will build if I know treatment like said Owner's husband.

[00:44] Audrey: You mean Owner?

Ade: Yes, like Owner said, if you have a good treatment in bamboo and replace it 5 years' time, 5 years, you can build in bamboo, you can get the long terms.

[01:07] Audrey: Actually you treat it and then you can keep the same a long time, just have it treated every 5 years. And you can keep it a very long time. The treatment is like you soak the bamboo in really big baths and you leave it there in the chemicals, and then you dry it and you can just leave it like that. Just have to replace the along-alang.

So why would you build in bamboo?

Ade: Because it's environment friendly, cheaper one. Because you know the concrete is very expensive and it's cheaper, bamboo is good.

[01:55] Audrey: How long do you think it can last now?

Ade: More than 10 years. Maybe same like my house 20, maybe even more than 20.

[02:10] Audrey: So what changed your mind?

Ade: Because I know I can support the local bamboo, and I have to maybe promote and have the bamboo in Bali. And I can build the bamboo, a house with the bamboo and good treatments and you can build a good one and make it comfy.

[02:45] Audrey: Is there something that would stop you from building in bamboo? Like is there a condition?

Ade: Well maybe if it's in the rainy season if the mouldy or the termites, this would stop me. But once again, if I have the good treatment, yeah, bamboo is a good solution for me right now.

[03:12] Audrey: What in your opinion is the range of cost of bamboo construction? So for a bamboo house, how much do you think it would cost?

Ade: The nominal or maybe just for...?

[03:26] Audrey: For an average house like this one?

Ade: Not too expensive, like maybe you can spend, cheaper, more cheaper than if you use the furniture like wooden. Or like less, maybe yeah cheaper than those.

[03:45] Audrey: Could you say a price?

Ade: Maybe 15 million, you can have a bamboo house and the with a good furniture.

[03:59] Audrey: How big the house?

Ade: Just like Owner's house.

[04:04] Audrey: Ok, like Owner's house. So to sum up is there something that you want to say, something you want to add?

Ade: For bamboo maybe in my house, maybe I can combine with the wooden because I think mix-and-match bamboo and wooden is also good. And for the interior, maybe I can put some just like still like stone, like what's best in Owner's, like the bathtub in stone. Yeah it's good to mix and match with the local brands and architecture.

[04:58] Audrey: Thank you very much Ade, you can send me Devi. Suksuma!

Ade: Mowali.

O. TRANSCRIPT 12 – IN-DEPTH INTERVIEW OF DEVI MARIANI, EMPLOYEE

[00:01] Audrey: Ready?

Devi : Yes.

[00:03] Audrey: Ok now it is recording. Can I ask you to remind us your name?

Devi : My name is Devi Mariani.

[00:08] Audrey: And where do you live?

Devi : I live in Denpasar.

[00:13] Audrey: And how old are you?

Devi : I am 22 years old.

[00:17] Audrey: Ok. What is your main occupation, what do you do?

Devi : Now?

[00:24] Audrey: Are you still a student?

Devi : No I am working.

[00:28] Audrey: Where do you work?

Devi : In hospitality.

[00:37] Audrey: Could you tell me about your home?

Devi : I can tell but I not speak English so well.

[00:45] Audrey: Ok just try and if you don't really know you can say it in Bahasa Indonesia and I will ask her friend afterwards to translate.

Devi : My home is... Tell like what?

[01:02] Audrey: Many people live in your home?

Devi : In my house we are 4 people: my father, my mum, and my brother and me.

[01:12] Audrey: How many constructions or rooms do you have?

Devi : I have a four rooms in the house and then one kitchen and one bedroom.

[01:25] Audrey: So 4 rooms plus kitchen and then bathroom?

Devi : Yes one bathroom one and also the living room one.

[01:35] Audrey: Now could you tell me are they all constructed together or is there more one room and then further another one... ?

Devi : In the living room: 1, 2, 3, 4.

[01:54] Audrey: And you have to go outside to go from one to another?

Devi : No, in the inside all. And then the kitchen inside, and then the bathroom one beside the kitchen.

[02:05] Audrey: What are the material that are used? Wood? Timber? Or maybe concrete? Or brick? [Audrey takes out images of the materials] Do you have this? Or this?

Devi : I have this.

[02:31] Audrey: Ok so concrete. Is your house made of this?

Devi : Yes.

[02:36] Audrey: Not bamboo or brick.

Devi : No.

[02:41] Audrey: Not wood neither?

Devi : What is wood?

[02:44] Audrey: [Audrey shows her a wooden column in the restaurant]

Devi : Oh. No.

[02:54] Audrey: What about your neighbours? Most people in Bali, do you think of the build in this or this?

Devi : This one.

[03:03] Audrey: Ok so most people build in concrete.

Devi : Sometimes maybe this and this.

[03:10] Audrey: Ok to sometimes bricks sometimes bamboo but mostly concrete.

Devi : Yes.

[03:19] Audrey: Why do you think people use this? Why is it good?

Devi : Because the concrete is the maybe... Murah. [indo. For cheap] down price maybe.

[03:40] Audrey: Cheaper?

Devi : Yes cheaper.

[03:46] Audrey: Ok so concrete it is cheap. No if you had to build a new home for you, maybe all the house or maybe just a kitchen, as you want, and you have as much money as you want so no money problem, which material would you choose?

Devi : I think like trees.

[04:14] Audrey: You mean wood? Timber?

Devi : Cayu jati [indo. For teak].

[04:20] Audrey: Ok good. Now if I tell you about bamboo construction, what is the first thing that you think about?

Devi : Bamboo sometimes we use it for the lying... In bahasa it is layan-layan [indo. For kite].

[04:44] Audrey: Ok I think I see what you mean. They use bamboo for that?

Devi : Yes. And then for the water?

[04:56] Audrey: You mean canalizations?

Devi : Yes. And for like this. [showing the ceiling framework]

[05:05] Audrey: For the roof?

Devi : Just for the rooftop. Maybe just... Just...

[05:16] Audrey: It's ok you can say it in Indonesian.

Devi : [speaks Indonesian : That's all I know. And I like because that is good for relaxing and meet with family.]

[05:28] Audrey: Would you, for your house, build something in bamboo?

Devi : No.

[05:35] Audrey: Ok why not?

Devi : Maybe someday I will try.

[05:45] Audrey: You can just say no, if you don't want to build in bamboo...

Devi : I don't know maybe it's interesting.

[06:00] Audrey: Ok if you don't want to build in bamboo, are you scared of something?

Devi : No.

[06:10] Audrey: What do you think if your neighbour build something in bamboo, what think of his house?

Devi : I cannot tell this in English. Maybe can you replay your question?

[06:33] Audrey: Ok if your neighbour or maybe a friend builds a house in bamboo, what are you going to tell them? What would you think.

Devi : I think it's good, yes. Just like that.

[06:48] Audrey: How long do you think it is going to last?

Devi : Going to finish?

[06:54] Audrey: I mean, it's built but how long do you think it's going to last in time?

Devi : I think it is a long time maybe.

[07:03] Audrey: Ok how long?

Devi : 5 years or maybe 10 years.

[07:09] Audrey: Ok so these are images of materials: could you put the cheapest here and here the most expensive?

Devi : Cheapest this, in this expensive.

[07:31] Audrey: Ok so concrete, I will repeat for the record, concrete and brick of the same, the cheapest then bamboo more expensive.

[interaction with the owner of the house we'll visit later]

[08:01] Audrey: So now I am going to show you a couple of pictures, can you choose three?

Devi : I choose one?

[08:14] Audrey: Three.

Devi : Three, alright. [looks at the pictures]

[08:34] Audrey: You can either choose pictures that you like or that you don't like.

Devi : I like three and I don't like three?

[08:43] Audrey: You can just pick 3 and then comment what you like or don't like. You can choose 4 if you want.

Devi : This is so good, what is that?

[09:02] Audrey: That is mud, adobe, construction. Made from earth and then bamboo for the roof. Why did you like it, why did you choose this? What did you like?

Devi : The look., lookness.

[09:19] Audrey: Ok the look, is it the shape?

Devi : Yes.

[09:26] Audrey: Or is it the colour?

Devi : Colour!

[09:32] Audrey: Ok so colour and shape. And what do you think of this?

Devi : It is good. I like the white. Yes. And then this maybe. And the rest is good. Overall it's ok, this I like this.

[10:14] Audrey: What do you like about it? Why is this better than concrete for example? Is it better than concrete?

Devi : In Bahasa it's ok? [speaks Indonesian]

[10:53] Audrey: Ok thanks I will translate later.

Devi : I'm sorry.

[10:56] Audrey: It's ok it's fine, I don't speak Indonesian and you speak English that's good. Can you choose the last one?

Devi : Last one, yes. I think this one.

[11:25] Audrey: Do you like it?

Devi : Yes.

[11:34] Audrey: What do you like about it?

Devi : It is the same, the look, and for the look the view it's good. I mean over there. And then... That. What is the name?

[12:04] Audrey: Alang-alang.

Devi : Alang-alang yes. In Bahasa, is rapi [indo. For neat]. Rapi and simple, it's the look simple.

[12:20] Audrey: Can you remind us quickly the good and bad sides of bamboo to you?

Devi : Of bamboo?

[12:30] Audrey: Just in general, what is the good and bad of bamboo.

Devi : Is the good... Is the bad maybe in bahasa, has rayap [indo. For termites]. Is the...

[12:48] Audrey: Termites or dust?

Devi : Yes dust maybe, pasir [indo. For dust]. And then makes it dirty. And the good of bamboo is the strong.

[13:15] Audrey: Thank you, we're finished.

P. TRANSCRIPT 13 – COMMENTED WALK OF DEVI

[00:01] Audrey: So I am starting to record you. You will be filmed. So now I am going to ask you: what in your home do you want to change or add? Construct new?

Devi: Change? Building?

[00:19] Audrey: Did you want a new bedroom or a new kitchen?

Devi : One more bedroom.

[00:27] Audrey: Ok so now we are going to visit a building and it's your new bedroom. We just built a new bedroom. It is not a bedroom that you can imagine that it is. Imagine that this is your bedroom. Ok?

Devi : Ok.

[00:43] Audrey: So just forget that there is this. This is like a sofa, and then we go into your bedroom. So this is your bedroom.

Devi : Ok.

[00:57] Audrey: This is your bedroom. What do you think?

Devi : May be too small.

[01:03] Audrey: Ok it is a small bedroom. What do you think of the place.

Devi : Good and simple. Simple, I think simple.

[01:22] Audrey: So where would you put your bed?

Devi : I'd put my bed here, like that, yes. And then this is like hum...

[01:34] Audrey: A cupboard? For your clothes?

Devi : No, no, like a table. And then this is the lemari [indo. For cupboard]. For my clothes. I think this is the... Same like air conditioner. Like this.

[02:06] Audrey: No how do you like it. Do you like the touch?

Devi : No it is too hot. And the touch is good but not smooth...

[02:22] Audrey: Ok so not smooth enough?

Devi : Yes, not smooth enough.

[02:28] Audrey: And the look? Is it pretty or not?

Devi : Simple, in Bahasa: sejuk! [Indonesian for "cool"]

[02:44] Audrey: How do you feel?

Devi : Comfort and lonely.

[02:49] Audrey: Lonely?

Devi : Yes lonely but this is great for the me-time.

[02:56] Audrey: Ok for the me-time, nice. Now the smell is ok?

Devi : Yes ok.

[03:04] Audrey: And the sound maybe? Like when you walk? Is it not too noisy?

Devi : No, it's ok.

[03:12] Audrey: And the light maybe?

Devi : The light maybe because I am scared of the dark so if we have a lamp...

[03:25] Audrey: Do you think it needs and learn to during the day?

Devi : No it's for the night.

[03:35] Audrey: Ok so that was your nice bedroom. Now I'm going to take you to another place but what happened is that there was an earthquake, the ground shaking.

Devi : No.

[03:51] Audrey: I'm telling you imagine your house got destroyed, you've got no house.

Devi : Ok.

[04:04] Audrey: You ask people to build you a new house because you had no house. And they were going to visit your new house.

Devi : Yes ok.

[04:12] Audrey: Ok so this is your new house and you're going to discover it. I want you to tell me what you think the new house. If you like it or if you don't like it, maybe the lights, the smell... When you touch it, the texture...

Devi : Ok.

[04:30] Audrey: Feel free to go.

Devi : Thank you.

[04:34] Audrey: Can you just take out the shoes just before we go in the house?

Devi : Yes sure.

[04:58] Audrey: You can come in.

Devi : Hello!

Owner: Selamat bahan, welcome to your home. Make yourself at home. Here's your coach.

Owner's wife: You can test it.

[05:17] Audrey: Yes the bamboo coach sounds comfortable.

Owner: If it wasn't for the cash we would have moved out.

[laughs]

[05:26] Audrey: Ok so let's have a seat. So how do you feel about the house?

Devi : Good, good.

Owner: [laughs] You can say it's bad it's ok.

Owner's wife: you're going to need a lie detector. [laughs]

[05:44] Audrey: Look and say what you feel in Bahasa Indonesia, I'll get someone to translate later.

Devi : Smell is good, it's comfortable.

[05:54] Audrey: Yes, thanks to the coach. It's comfortable.

Devi : Yes, I want to sleep here.

[06:06] Audrey: What about the place do you like the shapes?

Devi : Yes simple shapes and then the lights. Maybe someday when I grow up I can live in a place like that. It's good.

[06:24] Audrey: Is there something you don't like?

Devi : No it's good.

[06:31] Audrey: Do you feel at home or comfy here or...?

Devi : I feel like I want to have a home like this.

[06:42] Audrey: Ok nice. Do you want to go upstairs?

Devi : Yes. And all of that is made with bamboo?

[07:12] Audrey: Yes. This is alang-alang, ...

Devi : Can I see that?

[07:23] Audrey: Yes of course. Ok so you've got a bit of storage. [Devi touches the bamboo] Do you like the texture here?

Devi : Yes it's really smooth. Better than before

[07:42] Audrey: Smooth enough?

Devi : Yes enough. It's all good.

[07:56] Audrey: Is there anything you would like to change, if this is your home?

Devi : Maybe this one, change. Because if it's rains... [shows the open window]

[08:16] Audrey: No this doesn't leak, because you know goes on top of the other one.

Devi : I really like it.

[08:31] Audrey: Do you feel peaceful?

Devi : Yes peace!

[08:42] Audrey: What about the smell?

Devi : The smell is good.

[08:48] Audrey: How about the noise? Do you think it's too noisy? And downstairs? They are talking downstairs how about the sounds up here?

Devi : No really no noise except the "creek creek" like [walks to make the noise] I can't hear them.

[09:16] Audrey: Now let's go see the bedroom downstairs if you want to see it. Go ahead.

Devi : I feel cool.

[09:37] Audrey: Cold?

Devi : No not very cold, it's normal... Fresh!

[09:47] Audrey: And here's the outside bathroom if you want to have a look.

Devi : It's so simple.

[10:10] Audrey: If you don't like something don't hesitate, you can just say you don't like.

Devi : I don't like this maybe in Indonesia lumuk [indo. For moss]. It makes the mosquito come. Overall it's good I like this house.

[10:37] Audrey: Do you like the atmosphere? The way you feel?

Devi : It's good. Feels good.

[10:42] Audrey: Everything's good! Terima kasih.

Owner: Do you want to rent it?

Devi : What?

Owner: [speaks in Indonesian]

[Laughs]

Devi : I don't know is it cheaper?

[jokes in Indonesian, laughs]

[11:10] Audrey: Would you rather live here or in a concrete house in Denpasar?

Devi : I think this, because Denpasar it is very crowded, with traffic, it's hot... Too much.

[11:25] Audrey: Ok. Good.

Devi : Thank you very much.

Q. TRANSCRIPT 14 – INTERVIEW POST COMMENTED WALK OF DEVI

[00:03] Audrey: So how did you feel in the visit?

Devi : How do I feel? It's ok good, but just there were many mosquitoes...

[00:14] Audrey: Would you build in bamboo?

Devi : Yes I will someday.

[00:19] Audrey: Why?

Devi : Because it is like new, but this might be like one year, two years... But then Owner's house is 10 years already! I think it is a long house. It will be a long house if I build with bamboo.

[00:44] Audrey: And if one of your neighbours built with bamboo, what would you tell them?

Devi : Sorry can you repeat?

[00:53] Audrey: Or if one of your friends for example build with bamboo, for example Ade? If she built in bamboo, what would you tell her?

Devi : They should build like the room for the relax.

[01:09] Audrey: How long do you think of bamboo construction can last?

Devi : 10 Years maybe,10 years maybe more.

[01:03] Audrey: Owner's home is already there 10 years.

Devi : And it looks new, a new home. I think it is like a new home.

[01:29] Audrey: Ok good.

Devi : But then, 10 years, I'm shocked! Because all, the furniture like small and all look fresh.

[01:41] Audrey: So do you think it can last more than 10 years?

Devi : Yes.

[01:46] Audrey: How long?

Devi : I think 15 years maybe.

[01:58] Audrey: Did you change your mind about bamboo construction during the visit?

Devi : No, same.

[02:11] Audrey: The visit didn't change the way you feel about bamboo?

Devi : No.

[02:22] Audrey: Can you think about something that would stop people from building with bamboo?

Devi : No.

[02:30] Audrey: What is the range of cost, from your point of view, is a bamboo House? Price?

Devi : I think it is expensive.

[02:39] Audrey: How much?

Devi : 15... No. I think until 20 million rupiahs.

[02:50] Audrey: For a home how big?

Devi : For a home like Owner's.

[02:57] Audrey: Ok so 20 million.

Devi : Yes.

[03:00] Audrey: To sum up is there's something you want to add or to tell me? Is there a question you want to ask me?

Devi : I think no.

[03:13] Audrey: Ok, well thank you then. It's finished. Thank you very much. Suksuma!

R. TRANSCRIPT 15 – IN-DEPTH INTERVIEW OF NGURAH WIDI, RETIRED

Ngurah : Ok so can I read the questions first?

[00:03] Audrey: Yes, of course.

Ngurah : Because for the English... Uuh. Description...

[00:21] Audrey: This is in French, it describes how this is supposed to go. I describe the questions and then the visit.

Ngurah : Now here, from now, I'm going to ask you to repeat your name, where you live, your age and your job.

[00:30] Audrey: And then the other questions. So this is the beginning of the question.

Ngurah : What are the pros and cons... What is pros and cons?

[01:10] Audrey: It is the good and bad, you know?

Ngurah : Of this material?

[01:16] Audrey: Yes the advantages and disadvantages.

Ngurah : Pros is advantages?

[01:24] Audrey: Yes and cons is disadvantages.

[Ngurah continues to read the questions]

Ngurah : What a barrier?

[02:34] Audrey: Something that stops you.

Ngurah : And encouraging?

[02:58] Audrey: It's something that will push you to use it, to encourage. I am going to translate that word for you in bahasa indonesia. Wait...

Ngurah : I have to answer this in English or Indonesian?

[03:18] Audrey: If you can answer in English, English is better but if you really don't know you can say it in Bahasa Indonesia, helping me to translate. Her, encouraging in Indonesian is this: [shows it on the screen].

Ngurah : What is to sum up?

[04:17] Audrey: To finish, or to resume.

Ngurah : [continues reading]

[04:47] Audrey: And then after that, it is finished, we will go to the visit.

Ngurah : Now?

[04:55] Audrey: No after this.

Ngurah : Ok. Can I have one copy?

[05:06] Audrey: Actually this my copy, I've only one.

Ngurah : Oh just one copy.

[05:10] Audrey: Yes. So can I ask you to repeat your name?

Ngurah : Kristi Ketut Ngurah Widi Arthur.

[05:18] Audrey: And where do you live?

Ngurah : I live in Blumbungan.

[05:24] Audrey: Ok, and how old are you?

Ngurah : Now I'm 65 years old.

[05:30] Audrey: And what is your job or main occupation?

Ngurah : I am retired from educational for the department.

[05:48] Audrey: Now could you tell me about your home? How many people live here with you?

Ngurah : So I live with my wife and my granddaughter.

[06:08] Audrey: What are the convenience you have? So you have a kitchen... Many rooms in your house?

Ngurah : So I have a kitchen, I have a dining room, I have a bedroom and toilets. And also I have a place to sell somethings.

[06:32] Audrey: Ok, and what are the materials that are used to build your home?

Ngurah : I use brick and cement and wood.

[06:45] Audrey: What would you say are the most used materials in Bali?

Ngurah : In the city most of the material used Brick and Wood. But in the countryside most people use bamboo and also materials around they live.

[07:20] Audrey: Ok so we're done with the first part, as we were really quick we might want to skip the break. If that is ok?

Ngurah : Uh uh.

[07:34] Audrey: I'd like you to tell me about the pros and cons of the material that you that you use in your house? What are the good things about brick and cement and wood?

Ngurah : So actually the bamboo buildings most health than brick and wood. But the bamboo construction is less strong than brick and wood.

[08:08] Audrey: Strong against what?

Ngurah : Lasts... Maybe the bamboo 20 years of 15 years until 20 years. But the bricks until 30 years and more than that.

[08:23] Audrey: And why is Bamboo going to end after 20 years, what is going to happen?

Ngurah : In Balinese we don't use chemistry and things like that, it isn't natural. I don't know they just get things like this.

[08:48] Audrey: Oh dust?

Ngurah : Yes. For example with the insects inside. And then there is this.

[08:58] Audrey: Ok, so this falls. If in your house you wanted to build a new construction, what would you like it to be?

Ngurah : I'd like to use brick and wood. Because it is easy to take care of. In Indonesia, I don't know what it is called, bamboo is... Uh... I will speak Indonesia. [speaks Indonesian: I like to use bricks and woods. Because these is easy to take care. Bamboo is preferred by "Ani-ani" (honey bee) in Bali. And they have insect or termite inside the bamboo.] And then other insects.

[09:50] Audrey: Will eat it?

Ngurah : Yes, they will eat it.

[10:00] Audrey: Ok. So what are the first things that come to your mind if I ask you about bamboo construction?

Ngurah : The bamboo construction is... uh... what is it? Good and arts and natural.

[10:22] Audrey: Now if one of your neighbours or one of your friends here build a house in bamboo, what would you tell them?

Ngurah : For me it is very natural which is good for me.

[10:37] Audrey: How long do you think a bamboo house lasts?

Ngurah : Until 15, until 20. 15 years until 20 years.

[10:50] Audrey: Can you think of anything stopping people from using bamboo?

Ngurah : Stopping? Because to build with the bamboo material it is very expensive take care of, we have to often take care of that.

[11:07] Audrey: Ok so the maintenance?

Ngurah : Yes, the maintenance. It is more maintenance used bricks and things like that.

[11:14] Audrey: Is there relation to stop people from building with bamboo? Does the government do anything to stop people from building with bamboo? Can you choose any material?

Ngurah : No, no, no. The government allows everyone to use bamboo construction the government also advises the villagers to use the materials from nature in Bali.

[11:46] Audrey: Ok good. I'm going to ask you to rank this three materials. So this is Bamboo, brick and concrete, beton. Where does break it comes from earth that you take, you cook it. This is concrete, from sand, cement, rocks and water. Now I want you to rank it from the cheapest to the most expensive.

Ngurah : This is cheapest, this is the cheapest one. And then this and then this.

[12:28] Audrey: So I repeat for the record: bamboo is the cheapest, and then concrete is medium, and brick is the most expensive. I am going to show you pictures and I am going to ask you to choose three you can choose them because you like them or you can choose them because you don't like them.

Ngurah : So I have to choose three of this? So the first I like this, and then this. And then this one.

[13:51] Audrey: Now can you take these pictures and tell me why you chose them?

Ngurah : Why I chose them so these three pictures, they are really close with nature. Like this. It is good for the bamboo with this, with the nature and with the forest.

[14:28] Audrey: What do you like in this construction? Do you like the colours or the shapes maybe?

Ngurah : I think the colours is good, still natural you know. It is much with this in this.

[14:48] Audrey: With the green and the beige?

Ngurah : Yes.

[14:55] Audrey: How about the shape of the house?

Ngurah : The shape?

[14:59] Audrey: Do you know what shape is?

Ngurah : In Indonesia: aman? [Indonesian for safe]

[15:08] Audrey: No bentuk.

Ngurah : Oh bentuk, can you repeat your question?

[15:12] Audrey: What do you think of the shape?

Ngurah : Yes the same for me is very very artistic.

[15:18] Audrey: Do you think artistic is good or not good?

Ngurah : Good for me.

[15:28] Audrey: Ok very nice. Terima kasih. Can you think of strong incentives encouraging people to build in bamboo?

Ngurah : It depends on the material that they can find in the area.

[16:30] Audrey: Now to finish is there anything you want to say or add? That you haven't said already?

Ngurah : The bamboo construction, it is good for the health and then artistic.

[16:55] Audrey: Ok good, thank you.

S. TRANSCRIPT 16 – COMMENTED WALK OF NGURAH

[00:02] Audrey: So I am going to record you. Come this way. Now I want to know if you were to build a new construction, maybe storage, for your house, and this would be it, I'd like to know what you like or don't you like. So here we are. What do you think?

Ngurah : This building, what is it used for? Storage?

[00:47] Audrey: For storage. It could be used for something else. What would you use it for?

Ngurah : In my mind it is dirty. It's not clean and then the connexions with the hut, but when I see, it's dirty and not health.

[01:18] Audrey: Not healthy?

Ngurah : Yes. Not healthy.

[01:21] Audrey: And here do you think it is not healthy?

Ngurah : Yes because there is dust.

[01:30] Audrey: If we cleaned it, do you think the building is healthy?

Ngurah : Yes. Because you know the second one it is good for ventilation. You know with the... [shows the opening on the ceiling]. So the alang-alang, we call it in Indonesian alang-alang, for me the best look, alang-alang. Because when it is hot, it keeps cool. When it's cool, it keeps the hot. That is good, for me it is very very good this room. But they have to change it, every maybe about 10 years, you have to change it. When 5 years, it looks like not good, for me it is essential in order to be good-looking.

[02:49] Audrey: Do you like this place?

Ngurah : Yes I like this natural. What is it? Bamboo?

[02:56] Audrey: This one is mud. You take Earth, you compact it...

Ngurah : What is it inside? Just bamboo?

[03:04] Audrey: Yes, like this.

Ngurah : This is good to keep the weather good. To keep cool, what is it?

[03:24] Audrey: Ventilation?

Ngurah : No...

[03:26] Audrey: Air-conditioning?

Ngurah : Yes, you don't need! Because when I was a child my grandfa we used this. Mud.

[03:39] Audrey: So in your house, when you were little, you had mud?

Ngurah : Yes, but I didn't know this was mud because when I was a child it was big.

[03:49] Audrey: Big wall, thick?

Ngurah : Yes. That's good I didn't think that was mud.

[03:57] Audrey: Do you like the touch, the textures, do you like this?

Ngurah : Yes it's natural. But if you build in the city, this is you know, very different from other system. But if you build it in this situation it is really good.

[04:13] Audrey: Why is it not good for the city?

Ngurah : Because it's not around you. If you have a city where most people dislike this it is good. If you on the other side and the other side build different, more than building, it is not good.

[04:35] Audrey: Why is it not good?

Ngurah : I think, you know, because like this, for me, it looks clean. But if you build like this, in this situation, this is very good.

[04:57] Audrey: Ok now we are going to go to the other place. This is the camera. Follow me. Careful, don't fall.

Ngurah : This is alang-alang.

[05:32] Audrey: Yes, this is alang-alang but it's old.

Ngurah : Yes maybe 5 years, so we have to take care of it.

[05:58] Audrey: Go ahead, don't forget to take off the shoes before we go in. This is a home. This is a house. Here, come in. Be careful with the cables. Now here, I will let you walk around you can go to the kitchen, the bedroom or upstairs.

[Ngurah goes to the owner, who he knows]

Ngurah : This is your place?

Owner: This is my home!

Ngurah : You have a nice home!

[00:03] Audrey: Do you think it is nice?

Ngurah : Yes, yes, very very artistic and natural. And you don't use air condition?

Owner: No.

Ngurah : That's very natural, that is very healthy! I cannot build like this, very expensive.

[00:03] Audrey: So do you think this is more expensive than concrete?

Ngurah : Yes. If you build like this it is more expensive than concrete.

[00:03] Audrey: So when you were thinking it before it you put bamboo as very cheap. But no you're telling me this is very expensive.

Ngurah : It depends when you showed me the buildings, it depends. Like this, I think so, is very expensive, not the material. Takes care of this building. To maintain. It makes it more expensive than... When you start to build I think cheaper than this, but when it is very long, more expensive this. I don't know, Owner, do you take care of this?

Owner: The roof is expensive.

Ngurah: With the alang-alang and having to change it. Alang-alang is more expensive than regular.

Owner: But I mean, how often do you refinish a concrete house?

[speaks in Indonesian:

Owner: How often you finish the concrete house? How many times you repaint?

Ngurah: I build this house since 2008 until now 2019. It's been 11 years. And still good. It depends, if the first work is not good, this only survive 2 years. How about ants? Is there any ants?

Owner: Yes, there is. For the first step we made the floor without any planning, so the result is not good for the bamboo house. On the other hand, if the first step we make the floor with good planning and our aim to get a good house with bamboo, it is be good then. And also good for house from concrete and with roof-tile or iron sheeting, it's all the same as long as we make planning before.]

[00:03] Audrey: I definitely have to translate this. I think it's interesting, I was missing on a lot.

[enters a friend of the owner who knows Ngurah as well, we all chat]

[12:27] Audrey: Do you have anything to say or do you want to add something? You maybe want to go upstairs to see the roof?

Ngurah : Ok.

[12:35] Audrey: Be careful in the stairs. What do you think of the stairs?

Ngurah : I have to be careful it's a bit slippery.

[12:50] Audrey: Yes. So slippery? Ok.

Ngurah : There's sounds.

[12:55] Audrey: It makes noise.

Ngurah : What is it?

[13:05] Audrey: There's a cat. So what do you think of here? What do you like what don't you like?

Ngurah : I like the construction style. It's a style that I like. But maybe when I was a child, so my parents and my grandpa used everything used bamboo, and then like this roof and all. Because they used to stay in bamboo buildings, I think I just want to make the new one. But when I see that I remember was a child, for me this is back to when I was a child, and that is good.

[14:08] Audrey: Ok, so good memories!

Ngurah : Yes I like it. But now when won't it end sometime... What they call [Indonesian word]. But the building like this you know needs, what is it: take care?

[14:37] Audrey: Maintenance?

Ngurah : Yes maintenance. It's very need time to maintenance. To clean and things like this.

[14:50] Audrey: Do you think it takes more time than a brick or a concrete construction?

Ngurah : It is more long to build it than brick construction. But it also depends on the site construction. Construction like this is more longer than when we builds... I think when I build with my experience like this building maybe you just need one month to build like this with the brick. But I think when I build like this, it is more... If you make it like this you build one by one. If you buy the ready one, it's very quick but more expensive. If you start from the raw material, it makes very long time. So when I was child, my grandfa he made himself one by one.

[16:10] Audrey: Very long!

Ngurah : Very very long.

[16:13] Audrey: How long?

Ngurah : Maybe one like this just takes 2 hours, this one. It's long about 4 meters.

[16:37] Audrey: And for the whole roof do you remember how long?

Ngurah : It depends sometimes they were 10 people to make it but when one person to make it maybe it takes around, it depends on the experience of the man. If she is experienced, maybe 30 minutes or 1 hour to make one.

[17:00] Audrey: You know a lot of things, you already know a lot of things about bamboo.

Ngurah : If there is no chemicals.

[17:09] Audrey: There's going to be little holes and then there's going to be dust. But here it's been 10 years, and there's no holes and it's still smooth.

Ngurah : I like the natural, good for ventilation and change of the air.

[17:30] Audrey: Air circulation?

Ngurah : Yes, air circulation.

[17:36] Audrey: Ok well very good. Be careful on the way down, don't fall.

Ngurah : If you make yourself, but if you buy already done it is very quick.

[18:10] Audrey: Is it cheap if you buy it already done?

Ngurah : Yes because now there's a lot of people making it, in Bangli or... Back then there was none, so it was my grandfather who made it. But now everyone you find...

[18:24] Audrey: Do you want to check out the bedroom? So this is the bedroom and the bathroom. Would you have a bedroom like this for you? Would you have a bedroom like this for you? Do you like this bedroom?

Ngurah : HUUU... There are many holes you know [airtight]. I don't like this many many holes.

[19:04] Audrey: For the mosquitoes?

Ngurah : Yes. [laughs] short time yes maybe one week maybe one month, for long-term I need like this. If you rent it just one month or just two months, that's for a long time for me it is not good. This is the bathroom?

[19:37] Audrey: This is the bathroom.

Ngurah : Interesting.

[19:56] Audrey: Ok do you have anything more you want to say?

Ngurah : That's all?

[20:06] Audrey: Yes that's all.

Ngurah : Owner thank you, bye-bye. [speaks Indonesian]

T. TRANSCRIPT 17 – INTERVIEW POST COMMENTED WALK OF NGURAH IN THE WAKE

[20:57] Audrey: I still have a couple of questions and then I'll let you go back. So did you like the house?

Ngurah : Yes.

[21:27] Audrey: Did you know Owner already? Did you know Owner from before?

Ngurah : Maybe he knows me but when we have a gathering, we join the Kulkul farm group when I was retired. But after retired we open the market and we have to school. A professional school. So we open, here we call it, my school Widia Mandala. This is a professional school so we have a program mechanic automatic, and then cook and hotel accommodation.

[22:25] Audrey: Nice, very good.

Ngurah : And then the school has a program in Denpasar: nurse.

[22:43] Audrey: You can sit here and I will ask you a couple more questions.

Ngurah : Ok.

[22:51] Audrey: So how did you feel in the visit?

Ngurah : I feel, what is it? Just I remember when I was a child because I used to live in like this house. So when... it was in about 1965.

[23:16] Audrey: For how long? How many years?

Ngurah : I leave my village at 1970 to go to Denpasar for the school, to continue my school. When I was secondary, elementary school and secondary school, I was there in a bamboo house.

[23:42] Audrey: What was the village?

Ngurah : Ubud. Ubud in 1965 it was like like this. A lot of bamboo. My house is covered with bamboo. When my father build a house, just cut the bamboo and then no chemistry. Not not not.

[23:59] Audrey: No treatment?

Ngurah : What is it?

[24:05] Audrey: The treatment, the freemite, the borax...

Ngurah : Not treatment. So when he cut the bamboo, he chose the good day for this. Just the good day.

[24:19] Audrey: Like a calendar?

Ngurah : A calendar. So yes. And the old one, not the young one, the old ones.

[24:27] Audrey: How long did the house last?

Ngurah : Like this, like 20 years, 25...

[24:42] Audrey: Would you build in bamboo now? Would you choose bamboo for a new house?

Ngurah : Yes, if I have... I'd like to build with bamboo if I stay in like this situation, I don't build with brick, I build with the bamboo. When I stay in like this. Because the brick construction, the cement construction is not good in this situation.

[25:21] Audrey: Ok, but you live close to here, you live in the village, you don't live in a big city. You don't build in bamboo though.

Ngurah : Yes, when I live in the city, I don't use bamboo. If I live like this, maybe I choose bamboo.

[25:48] Audrey: And how long do you think that house will last?

Ngurah : Maybe about 20, 20 years.

[25:58] Audrey: Did you change your mind on bamboo construction when we visited the house? With the visit today, did you change your mind on bamboo?

Ngurah : Change my mind? I just like to build with bamboo, it depends on the situation. Change minds, so what I said, I like to stay in like this stay if I live in this situation.

[26:52] Audrey: What do you mean by this situation.

Ngurah : In this kind of area, many trees. But in the city, there is not like this.

[27:00] Audrey: Where you live, do you call that the city?

Ngurah : In Denpasar.

[27:05] Audrey: I mean in Blumbungan. There is nature, right?

Ngurah : In Blumbungan, this is for the guest house, you know?

[27:26] Audrey: Ok. You don't live in Blumbungan?

Ngurah : I stay there sometimes but sometimes I live in Denpasar. Sometimes I live here.

[27:36] Audrey: Ok, I didn't know that.

Ngurah : That's why in here we use the door like Balinese you know. No many take care, we just clean. If we used this, it's very hard to clean. Cheap for the take care of this.

[28:14] Audrey: How much do you think a house like that costs?

Ngurah : Maybe 150 million to build like this.

[28:27] Audrey: And to sum up, do you want to remind me the pros, the advantages of bamboo and cons?

Ngurah : The advantage is it is natural and then it is good for the air, air circulation.

[28:53] Audrey: Natural ventilation?

Ngurah : And then what is it? It it more health when we always stay with the bamboo than stay with the brick you know? I think, what is this... [touches his nose]

[29:12] Audrey: The smell or...?

Ngurah : Maybe in brick, but the bamboo is natural. It affects my lungs. These are the advantages of the bamboo. The un-advantage, the worst of the bamboo take care should be half time to take care of this. And the second it that if there is no chemicals, worse... What is it?

[29:58] Audrey: Treatment?

Ngurah : Yes, then many ants come in.

[30:06] Audrey: Insects?

Ngurah : Yes. What is it the... lasts quickly. So we have to change. I don't know. In my house there is no chemicals, it's more difficult, just natural cut and then used like that. Not this one.

[30:45] Audrey: Yes this one is treated.

Ngurah : Is it the chemical effects now?

[30:52] Audrey: No, so you put it in a bath but then you let it dry. It's treated and dry so that insects doesn't want the dry material.

Ngurah : When I was a child, my parents just cut the bamboo and then put in the pool maybe one week until two weeks and then take out and let it dry.

[31:26] Audrey: Here, it is a bit like that but you add, in the pool, you add salts, special salt, boron salts, and the boron gets in the material. And then you dry it. It's dangerous when it's in the pool, you should wear glove to protect your skin, but normally, after it dries, it shouldn't get in your lungs. Very good. It's done. Terima kasih banya.

Ngurah : Terima kasih banyak.

T. IBCC CONTEST – HOUSE LOTI PROJECT

HOUSE LOTI

BAMBOO STRUCTURE FOR THE INTERNATIONAL BAMBOO CONSTRUCTION COMPETITION

BEIJING HORTICULTURAL EXPOSITION 2019

2019 04 29 1258 1063 69

Descriptive Report

1. PRESENTATION

1.1. PROJECT

Since the early landscape design, a balance between layout and water formed the basis of Feng'Shui. No landscape was complete without a pond, and no pond is complete without lotus.

Our goal: combine Western and Eastern construction, the traditional and the modern, to create a pavilion building that is adaptive, sustainable, and pleasant.

The word "blossom" inspired a dynamic design, being able to actually bloom: petals composing the walls of the closed flower can blossom into sunshade panels and seats.

The multifunctional pavilion has a small ramp to enter the first storey, about 50 cm above the ground. The second floor is only accessible using a bamboo ladder which can be hung upon a bamboo beam.

The structure is polyvalent and versatile as possible. The upper level can be used as a small resting space, for storage or even as a small office. The first floor might just be used for the same purposes, but it could also be used as for educational purposes. On top of the structure, a polycarbonate leaf shaped panel elevated from the top circular opening to provide the rain from getting into the pavilion whilst still letting light in and air out from the top. Thin interstices between the flooring slats will allow air to circulate from ground to sky, providing natural ventilation throughout the bungalow. (cf. Fig. 3)

The structure is covered with a two layers' skin made, from inside to outside, of bamboo woven panels and tent fabric. The fabric shall be 100% cotton, bio-epoxy covered and naturally dyed with yellow on top, left white

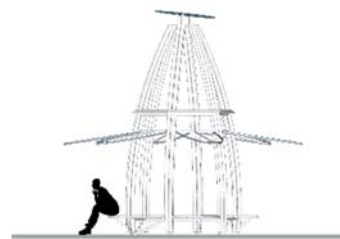


Figure 1- Man seating on a petal

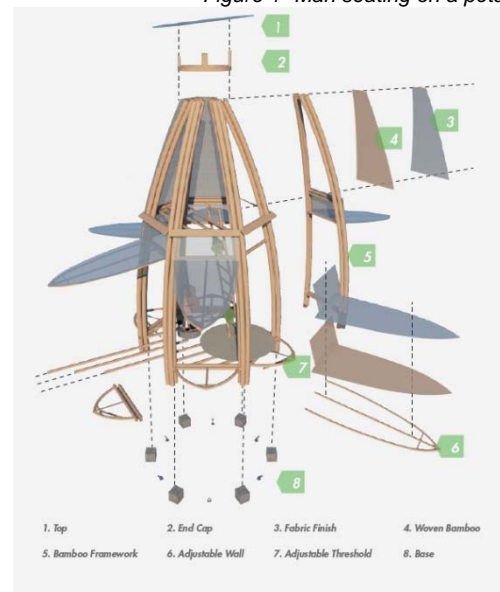


FIGURE 2- COMPONENTS OF THE STRUCTURE



(natural cotton white) for most of it and pinkish bits on the petal contours, using avocado for the pink and jackfruit and turmeric for yellow. These colours will recall some loti flowers.

FIGURE 3–BAMBOO FLOORING

1.2. STRUCTURE

The structure is made of six frames that are assembled with rope on site into a hexagonal shaped plan, primary floor structure and end cap on top. Each frame has 2 pivoting petals: 1 small pivoting into a seat and 1 large on top pivoting into a sunshade. The seat piece has a pivoting leg which can build into small metallic notch on the ground. The sunshades will be connected with a cable to a pulley system enabling the user to turn a hand crank opening the petals from the top floor or the ladder.

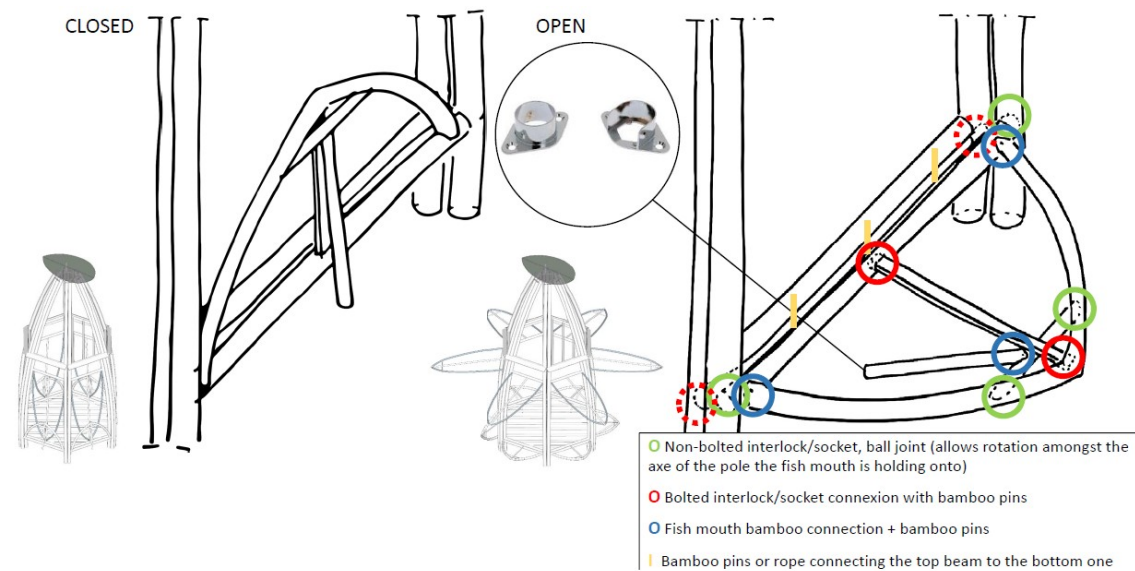


FIGURE 4– CLOSED AND OPENED SEAT PETAL AND TYPES OF CONNECTIONS

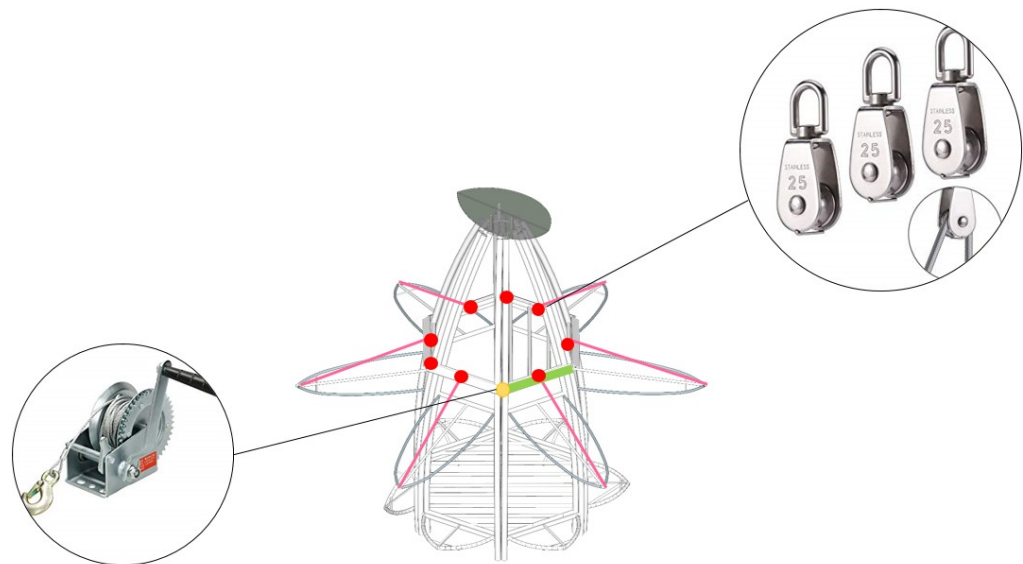


FIGURE 5– OPENED SUNSHADES AND POSITION OF THE CABLES (PINK) PULLEYS (RED) AND CRANK (YELLOW)

Small concrete foundation blocks are buried under the 6 major piles, connected with the structure by metallic connections (cf. *Fig.6*).



FIGURE 6– METAL PIECE FOR THE FOUNDATION CONNECTION

The sections used are described in the diagram below:

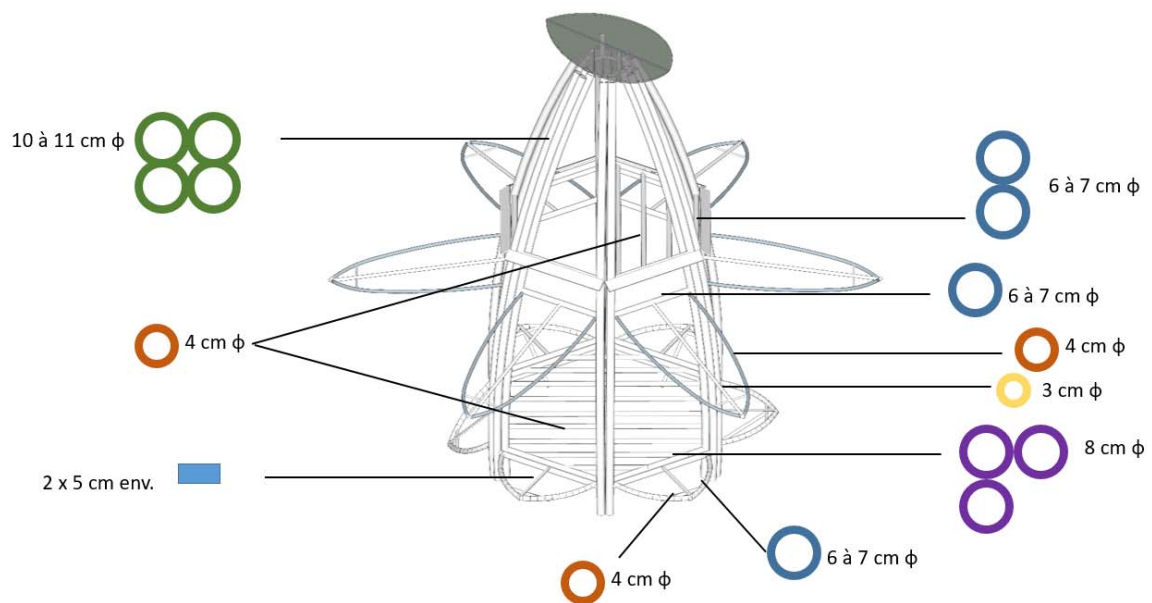


Figure 7– Bamboo sections

2. HYPOTHESIS

2.1. CONNECTIONS

Verifications of the connections is not detailed here but nevertheless respects the rules of good practices of the craftsmen of Belega, Bali.

2.2. MATERIALS

The main material used is Moso Bamboo. Its characteristics are the following:

- Density: 400kg/m³
- Elastic modulus: E = 9500 MPa
- Bending strength: $X_{m,d} = 20\text{MPa}$
- Compression strength: $X_{c,d} = 17\text{MPa}$
- Tensile strength: $X_{t,d} = 8\text{MPa}$

2.3. LOADS

- Self-weight: G
- Variable load: $Q = 4\text{kN/m}^2$
- Wind load: $W = 0.4\text{kN/m}^2$

The combination of loads in Serviceability Limit State is:

$$1.0 G + 1.0 Q + 1.0 W$$

The combination of loads in Ultimate Limit State is:

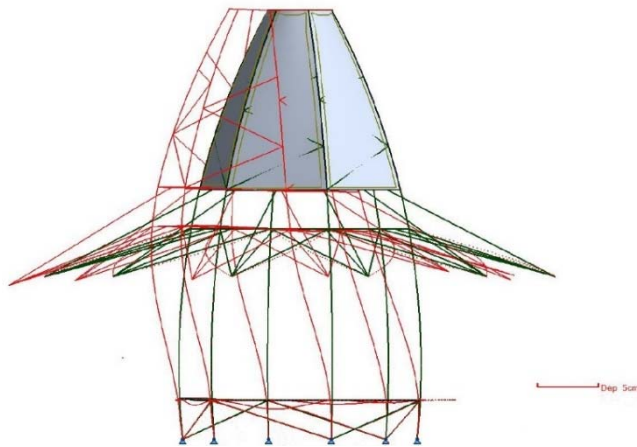
$$1.35 G + 1.5 Q + 1.5 W$$

2.4. NUMERICAL MODEL

The model was first made with Rhino 3D + Grasshopper then transferred to ROBOT Autodesk for the analysis.

3. RESULTS & VERIFICATIONS

3.1. SLS



The maximal displacement at the top of the structure is equal to 5.9cm.

This displacement, corresponding to $H/93$, is acceptable.

Figure 8: Deformed structure in SLS

3.2. ULS

The table 1 shows the maximal results of the analysis conducted with ROBOT software.

| Location of element | Section | Maximal compression force | Maximal tension force | Maximal bending moment |
|---------------------|---------|---------------------------|-----------------------|------------------------|
| Horizontal Top | 1Φ7cm | 6.18kN | 5.76kN | 3.28kNm |
| Horizontal Bottom | 2Φ8cm | 6.80kN | 4.39kN | 4.25kNm |
| Vertical | 4Φ10cm | 14.15kN | 9.55kN | 3.22kNm |

Table 1- Results of the analysis of the structure

The resistant forces and bending moment of each section is given in the table 2.

| Section of element | Resistant compression force | Resistant tension force | Resistant bending moment |
|--------------------|---|-----------------------------------|--------------------------------------|
| 1Φ7cm | $= \frac{0.6 \pi^2 A E}{\gamma \lambda^2} = 12.58 \text{ kN}$ | $= A * X_{t,d} = 5.84 \text{ kN}$ | $= S_e * X_{m,d} = 3.39 \text{ kNm}$ |
| 2Φ8cm | $= 34.78 \text{ kN}$ | $= 15.28 \text{ kN}$ | $= 4.18 \text{ kNm}$ |
| 4Φ10cm | $= 14.37 \text{ kN}$ | $= 47.75 \text{ kN}$ | $= 5.63 \text{ kNm}$ |

Table 2- Maximal resistant forces and bending moment

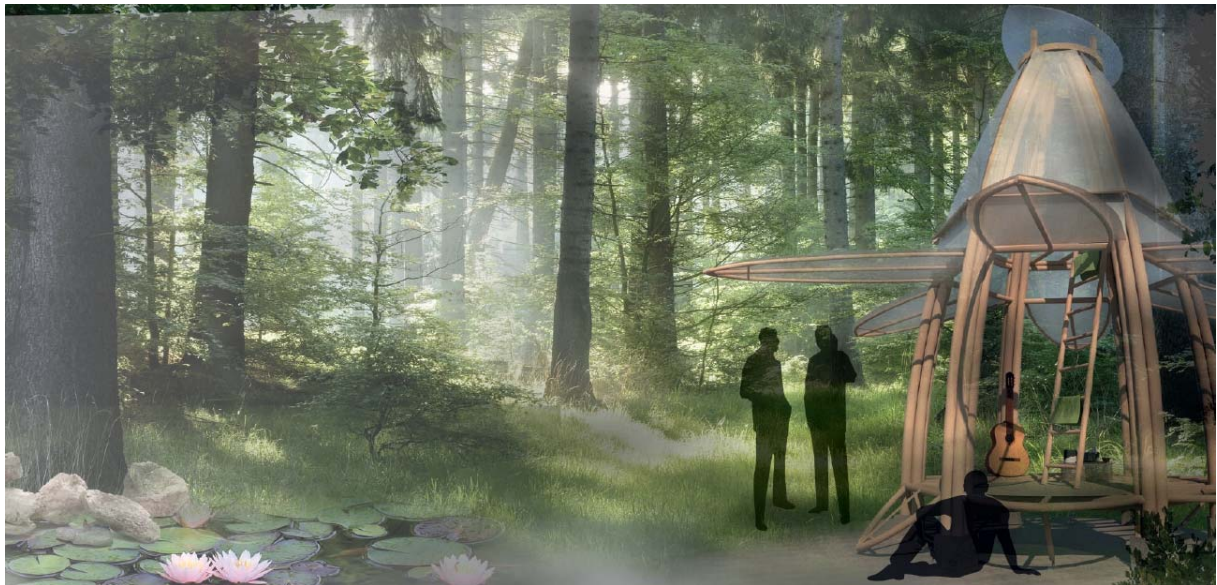
Combined bending and axial tension/compression is also verified.

3.3. SUPPORT REACTIONS

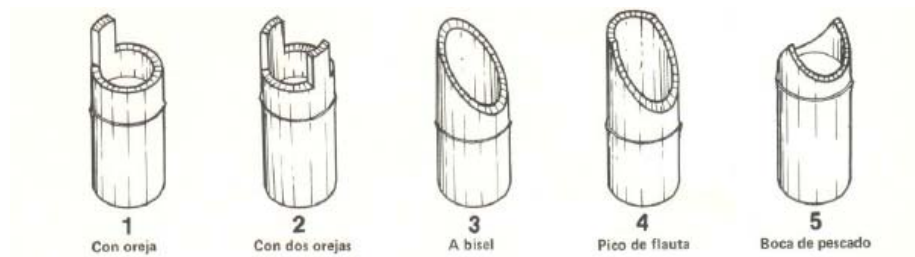
The maximal support reaction is 7kN in tension. The steel connection to the foundation will be able to carry out this force.

4. CONCLUSION

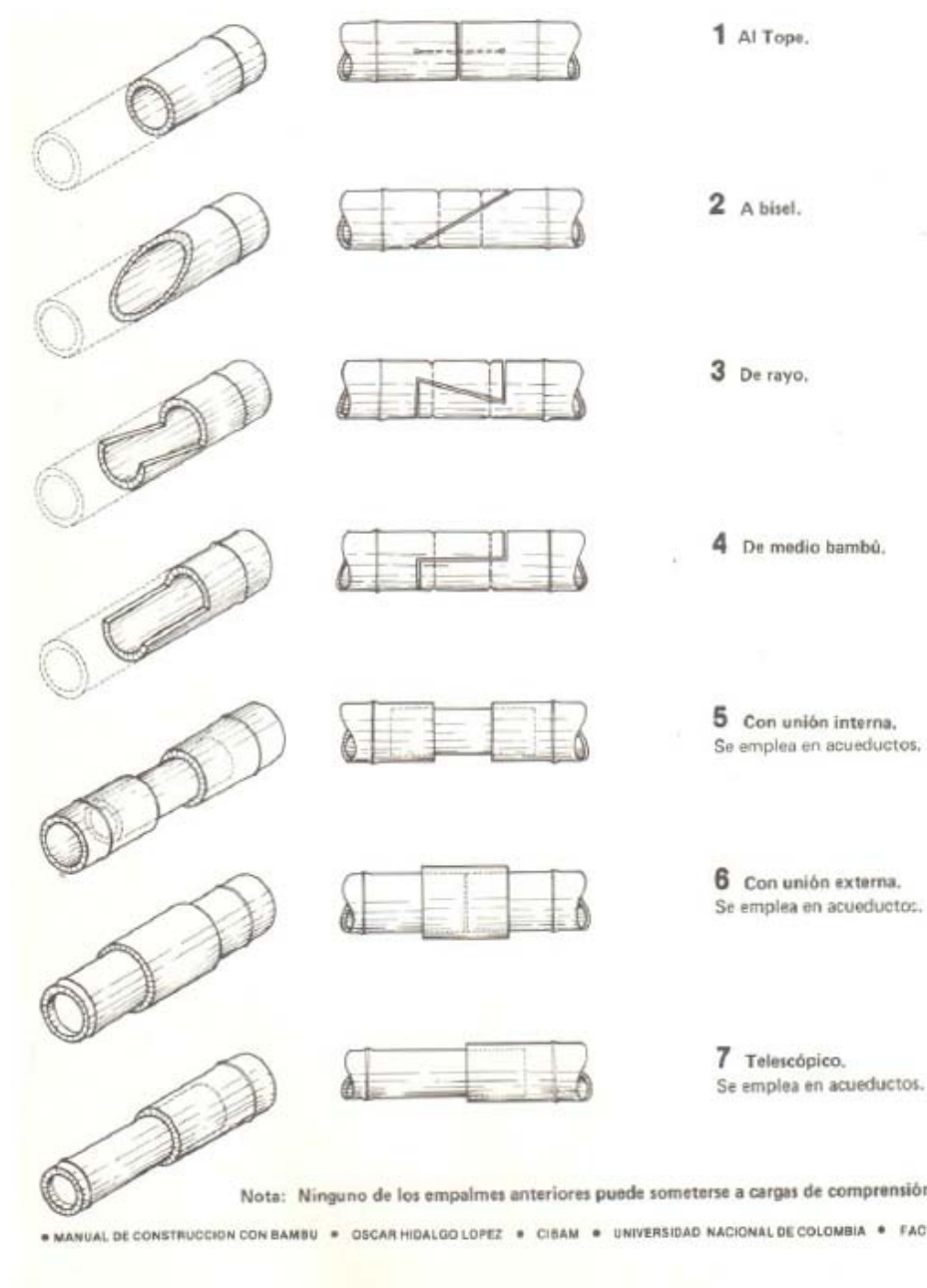
The pavilion shall be safe and ready to be constructed.



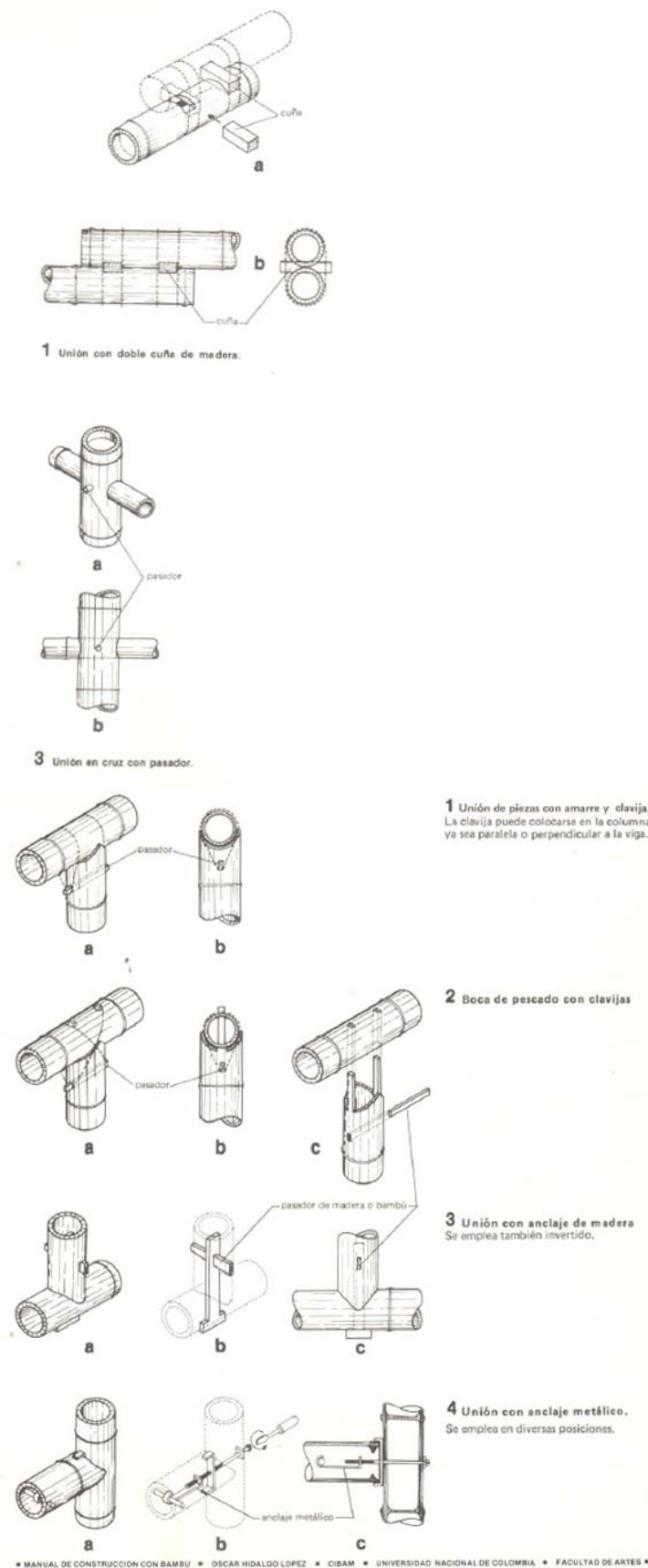
U. CONNEXION EXAMPLES



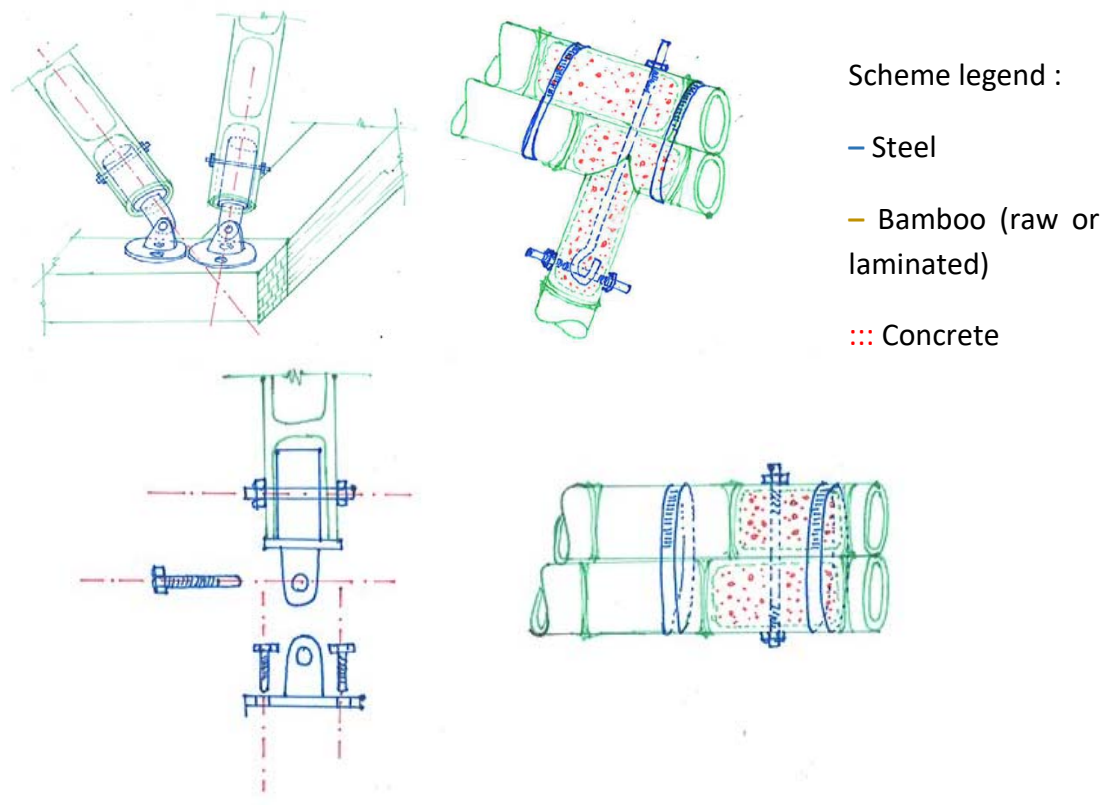
(Hidalgo & Diroux, 2018)



(Hidalgo & Diroux, 2018)



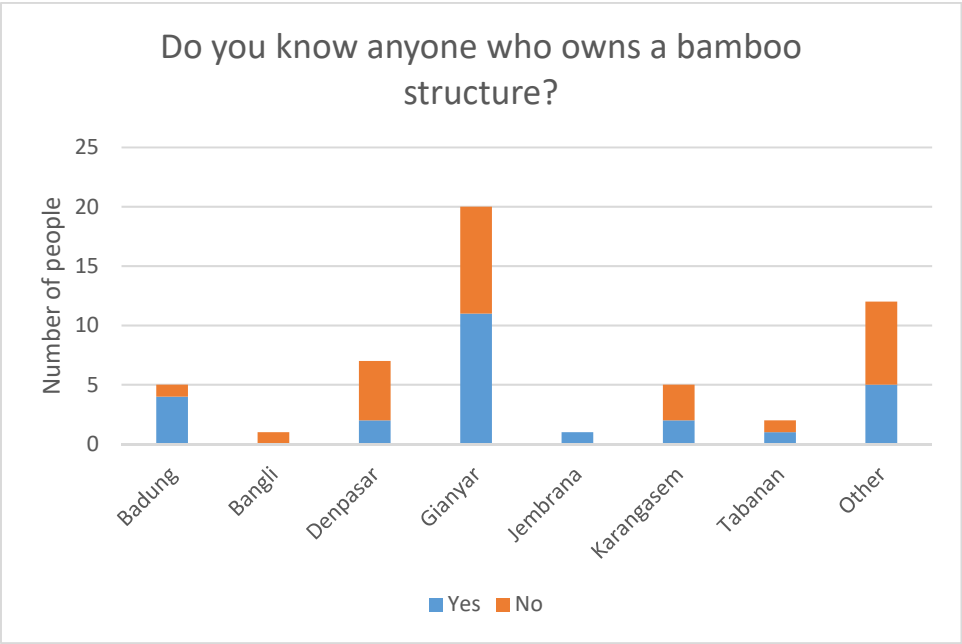
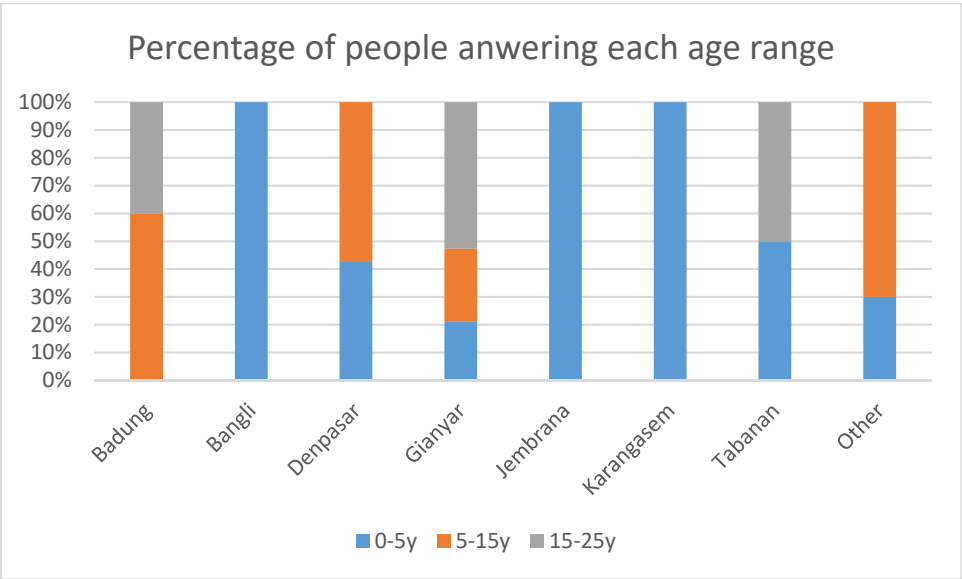
(Hidalgo & Diroux, 2018)



(Gonzalez, Frazer Mills, Buchhorn, 2019)

V. FURTHER DATA COLLECTED

V.1. ADDITIONAL DIAGRAMS



V.2. PICTURES OF THE COMMENTED-WALK BUILDINGS

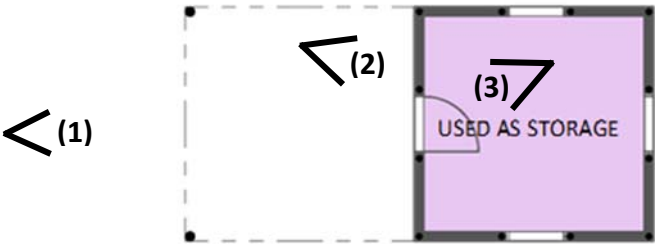
First building visited, the storage extension:



(1)



(2) (3)



POINTS OF VIEW

Second building visited, the owner's home:



(1)



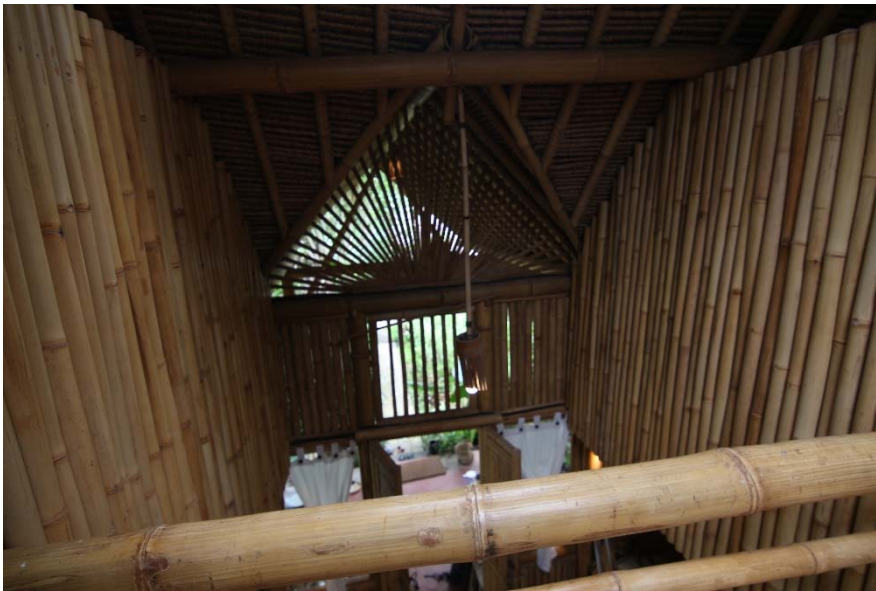
(2)



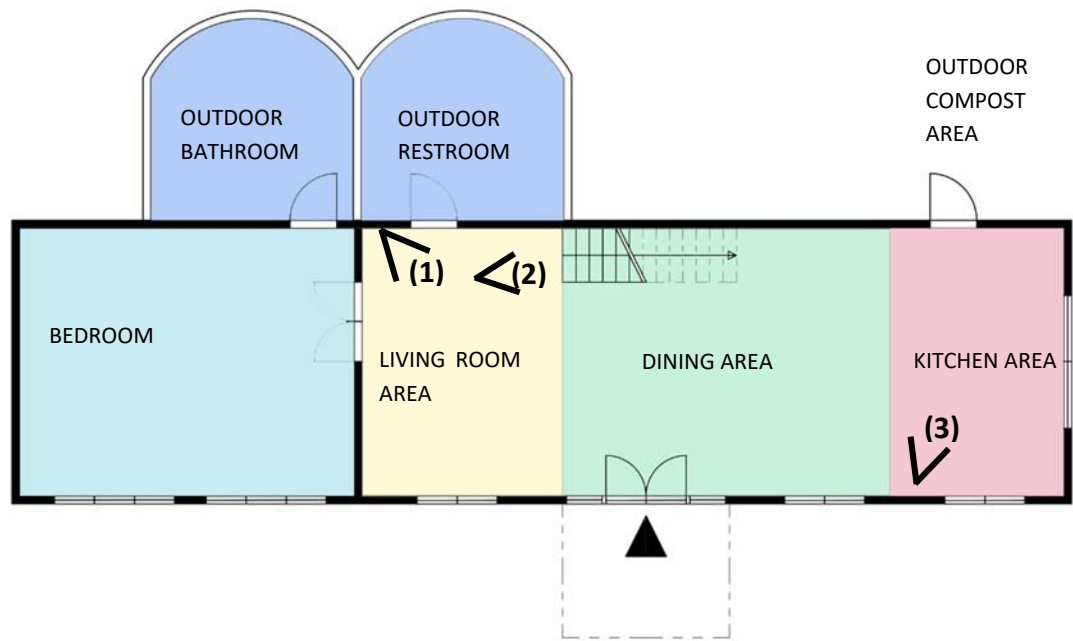
(3)



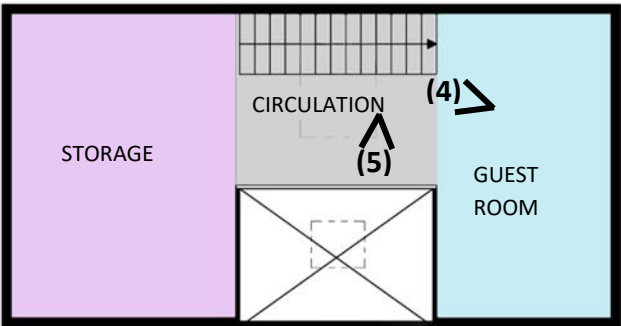
(4) Mezzanine



(5) Mezzanine



GROUND FLOOR POINTS OF VIEW



MEZZANINE POINTS OF VIEW

BAMBOO CONSTRUCTION

QUALITATIVE INDICATORS FOR HOUSING

Case study in Bali, Indonesia

Université de Liège – Faculté des Sciences

Appliquées

Master Thesis in order to obtain a master degree in
Civil Engineering and Architecture

by **Audrey MERTENS**

Academic year : 2018 – 2019

Promotor : C. ELSEN

Co-promotor : J.-M. FRANSSEN

Jury members : S. REITER

J.-M. BLEUS

F. COURTEJOIE