TOWARDS AN INTEGRAL APPROACH OF

SUSTAINABLE HOUSING IN INDONESIA

WITH AN ANALYSIS OF CURRENT PRACTICES IN JAVA

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PROEFSCHRIFT
ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. dr. ir. J.T. Fokkema,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen
op donderdag 11 januari 2007 om 15:00 uur door

DWINITA LARASATI
Master of Arts in Design Research van Design Academy Eindhoven
Geboren te Jakarta, Indonesia

Dit proefschrift is goedgekeurd door de promotor:
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Samenstelling promotiecommissie
Rector Magnificus, voorziter

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Eindredactie: Sybrand Zijlstra
Vormgeving en omslagontwerp: Yvo Zijlstra
Gedrukt op BioTop eco-papier
Foto achterzijde omslag: Transporting a house in Bulukumba, South Sulawesi
©1993 Walter Imber Photos

Keywords: sustainable housing, Indonesia, community participation

ISBN-10: 90-9021487-9
ISBN-13: 978-90-9021487-0

ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to God the Almighty, whose blessings have accompanied me all the way during the process of conducting my research.

I am very much indebted to my late promotor Prof. dr. ir. Charles Hendriks, who gave me trust and confidence when I started my research. His unmatched expertise has provided valuable guidance and is very much missed. May he rest in peace. I would like to express my greatest gratitude to Prof. Ir. Mas Santosa, M.Sc., Ph.D., for his supervision in the earlier phase of my research, especially concerning the passive-solar strategy for housing, (vernacular) architecture and for directing my research focus, and also for his warm welcome at ITS and ITS Eco-house in Surabaya. I would also like to thank Prof. Johan Silas, Dipl. Ing. Sri Nastiti Ekasiwi and Dr. Agus Windharto, DEA, for the very fruitful conversations we had at ITS. Hudi Danu Wuryanto and the PPLH team in Seloliman, East Java were very thorough in showing me around the unique PPLH compound. For their hospitality and valuable information, I am very grateful. In Jakarta, Mr. Johnny Anwar Z.S. at BPS has helped me a lot with important statistics and references, as did Ir. Laksmi Wijayanti, MCP at BAPEDAL, concerning the principles of Healthy Housing and its implementation in a dense urban areas. Many thanks to Dr. Ir. H. Martin Djamin at BPPT for his excellent information about photo-voltaic power generation for small villages, and to Ir. Gusti Firdauzy Noor for his explanations concerning the use of alternative building materials. At Kimpraswil I was welcomed by Ir. Arvi Argyantoro, M.A. who provided me with insight into housing policies and Ir. Ida Yudiarti who explained the use of gray water. Thanks to Mrs. Nuning Wirjoatmodjo from UNESCO Jakarta Office, who has provided thorough information about environmental activities in Banjarsari. My deepest respect goes to Mrs. Harini Bambang Wahono, a strong woman who has consistently lead her fellow inhabitants in Banjarsari Village to take care of their environment and who has become a great source of inspiration for me.

I would like to express my gratitude to Prof. Kees Duijvestein for his willingness to become my promotor and to supervise me during the final phase of my dissertation after the demise of Prof. Hendriks, which was one of the most difficult parts of the process. Working sessions with him have always been pleasant and vibrant, his mentoring always lead to interesting explorations. I am very grateful to Dr. Alex Fraaij who has always been there whenever I needed assistance during my regular working days and I often found solutions through our conversations. Dr. Jules Janssen, whom I have known since my earlier days of studying in the Netherlands, was, to my pleasure, willing to supervise me again for the bamboo part of my dissertation. Him being one of the most acknowledged persons in the world concerning bamboo building only honored me more. I am very grateful for his promptness in providing updated references and his support that uplifted my spirit through kind and vigorous words. I would not have reached the same clarity of thinking without the guidance of Dr. Machiel van Dorst, who was highly influential thanks to his expertise and his experiences in Indonesia. I offer my sincerest gratitude to Prof. Herman Haeruman for his insights towards the finishing phase of the research and for his assistance during a crucial point of the process.

To a group of Indonesian students in Delft (Mel, Santi, Sigit, Edwin, Andrew and Tigor) and in Amsterdam (Bulan, Tanti and Dika), who have taken part in the usability tests of the DCBA booklet and gave their input and opinions: please accept my gratitude. Indonesian students whom I met at conferences and other student programs in Europe during my study, I thank you all for your various insights towards my research subject, as well as towards living in foreign countries, both joy and struggle. My dear fellow students and researchers, we have shared a lot of happiness and grieves, let that be our priceless experience.

My gratitude also goes to my colleagues at TU Delft, who made my working days in Delft lively and lunch times memorable. I should also say that I would not have been able to go on without the support from my friends in Indonesia. Far apart as we are, we could still 'meet' everyday through emails and chatrooms accompanying me during my working days and nights, and cheering me up whenever I needed a boost.

My endless love, respect and gratitude go to my parents who have shown me perfect examples of self-improvement through their own struggles in life; my father a quiet, hard-working professional and my mother a cheerful, persistent scholar even in the most difficult situations. It is to them that I dedicate this dissertation. Many thanks to my siblings, Moeder Toos, in-laws, family and relatives for their continuous support and countless prayers. A special thanks for Yvo Zijlstra, who has been a great help in designing and lay-outing this dissertation in spite of his his tight time schedule. His work for this book and the booklet has given them a significant improvement in performance. Last but not least, I have Sybrand Zijlstra who is my coach, brainstorming partner, tutor, philosopher, encyclopedia, dictionary and thesaurus in one, technician and much more, to whom I feel grateful the most. Finally, to the jades of my heart: Dhanu and Lindri, who have been filling my life with bright, lively colours, and have never failed to cheer me up in any situation. Thank you for being so patient and understanding in coping with your always-busy mother.

DWINITA LARASATI
Amsterdam, December 2006

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1. INTRODUCTION

1.1 Background

Rapid population growth has put a pressure on the environment, causing impacts such as depletion of air and water quality, especially in dense urban areas, added by squandering of natural resources and fossil fuel reserves and an increasing volume of waste. Issues such as climate change and greenhouse effect have generated concerns and efforts towards better ways to provide a living space, while also minimizing damages to the natural environment. This effort has resulted in various forms of ecological dwellings and environmentally friendly buildings. An outstanding example is the autonomous house,[1] which takes its energy and water resources directly from its immediate environment without depending on any state-owned power supply; recycles and re-uses its resources before returning them to earth as bio-degradable waste. The effort to create sustainable domestic facilities has also lead to the production of tools that support the practice of sustainable building and has triggered further research and development of alternative energies and efficient use of water and other natural resources.

There are various definitions of *sustainable housing*, but all basically carry out the idea of Principle 15 of the Declaration of the United Nations Conference on the Human Environment: '*Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all*' (UNEP, 1972). The definition of sustainable housing by the European Union includes the following perspectives: construction (e.g. material durability), social and economic factors (e.g. affordability and psychological impacts) and eco-efficiency (e.g. efficient use of non-renewable resources) (VROM, 2005). Another source defines sustainable housing as: '*That which effectively integrates low energy design with materials, which have minimal environmental or ecological impact (in manufacture, use and disposal) whilst maintaining social diversity*' (IHBC, 1998). These definitions present the general point of a sustainable housing practice that is applicable under various circumstances, depending on the conditions where it is implemented.

Housing development in Indonesia is especially complicated in dense, vastly growing urban areas. Houses are built in haste, to be able to catch up with the rapidly growing population numbers. Priority is put on quantity instead of quality of housing, which has resulted in undesired consequences, such as houses with no or minimum indoor thermal comfort and no or minimum services for basic facilities (i.e. water and electricity resources). Lack of consideration to social-cultural circumstances has also led to problems such as low appreciation towards the housing by (potential) inhabitants, violations of policy, etc. Added to the mentioned problems are the domestic habits of the inhabitants, which are not suitable for urban living, such as careless garbage management (i.e. dumping household waste in rivers) and inconsiderate use of energy and clean water. These unfavorable activities have caused functional failure of infrastructure facilities such as water drainage, which leads to ecological urban disasters (i.e. flooding). In addition, environmental impacts occur not only in a certain housing area but easily spread to its neighbouring areas. Ecological problems in high density urban areas have reached a critical point. To mention two examples: a garbage dump in West Java that collapsed as a landslide, flattening 68 houses of a hamlet, killing 20 people while 73 others were missing,[2] and over-extraction of groundwater in Jakarta that has caused salt water intrusion and a high percentage of E coli bacteria pollution.[3]

The time is due to make a significant improvement by endorsing an integrated approach of the housing process and its influence on the environment, and on economic and social circumstances. Efforts to make this improvement by the method of reducing, re-using and recycling are possibly the most popular and their implementation the most commonly used up to now. However, these efforts of eco-efficiency must not be viewed as limiting the urge to develop, grow or explore natural resources and man-made facilities. Instead, this research encourages the viewpoint to see 'waste' (from a process/product) as 'food' (for other processes/products), or: *cradle-to-cradle* thinking[4] (McDonough & Braungart, 2002). This new way of thinking makes it possible for people whose professions deal with the built environment (i.e. architects, designers, engineers, planners, etc.) to discover innovative solutions that minimize waste, without limiting the use of resources. Opting for sustainable housing solutions whereby mankind is seen as a part of (instead of a threat to, or a ruler of) nature, would help in achieving a healthier and more humane domestic environment.

The choice of positioning human beings and their roles as a major consideration in the building process appeared as a reasonable inclination to me, considering my background as an industrial designer. Industrial design mainly explores relationships or interactions between (industrial) products and human beings (as users, manufacturers, etc.). According to the International Council of Societies of Industrial Design (ICSID): *'Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange.'*[5] Furthermore, ICSID describes the task of industrial design as: *'... an activity involving a wide spectrum of professions in which products, services, graphics, interiors and architecture all take part. Together, these activities should further enhance – in a choral way with other related professions – the value of life.'*

According to a definition of *industrial design* from the Industrial Designer Society of America (IDSA): *'the industrial designer's unique contribution places emphasis on those aspects of the product or system that relate most directly to human characteristics, needs and interests. [...] Industrial designers also maintain a practical concern for technical processes and requirements for manufacture; marketing opportunities and economic constraints; and distribution sales and servicing processes. They work to ensure that design recommendations use materials and technology effectively, and comply with all legal and regulatory requirements.'*[6]

These definitions provide a picture of how an industrial designer is used to emphasize human factors in dealing with production or manufacturing processes and with the output and usability of products. The industrial design discipline also requires extraction of various knowledge disciplines in conducting research or working on projects. The research for this dissertation was started at the Industrial Design Faculty; after changing to focus on the subject of sustainable *housing*, the research was continued at the Civil Engineering Faculty and it was finally completed at the Faculty of Architecture – all at Delft University of Technology. Based on this multi-disciplinary approach, the subject of sustainable housing appeals to me, not only due to the urgency of the matter, but also to the possibilities to orientate on the user aspect (or, in this case, on the housing occupants as end-users), beside the engineering viewpoint.

This research therefore:

- emphasizes the role of the local community in housing projects, and
- produces results that can be understood by common people and are suitable for direct application

This research carries the believe that sustainable housing practice is most successful when the needs of the inhabitants are effectively accommodated, and when the inhabitants are deeply involved in and capable of maintaining their own domestic environment. The lack of consideration for inhabitants has been proven to cause failures in housing projects. Examples from Aceh, Indonesia and South America illustrate the situation.

The Tsunami that hit Aceh and Nias at the end of 2004 and an earthquake in the beginning of 2005, have left both Indonesian provinces paralyzed and, soon after, in urgent need for restructuring and rebuilding. The initial estimation of people in Aceh who were displaced from their homes reached up to 500,000. These people have been compelled to live with relatives or friends, or were accommodated in tents or barracks.[7] For permanent housing needs, the Reconstruction Agency for Aceh and Nias (*Badan Rekonstruksi dan Rehabilitasi* Aceh-Nias/BRR) estimated that 120,000 units of new houses are required in Aceh and Nias. Tens of thousands of houses have been completed by now (July 2006), leaving at least 13,000 more houses to be built. However, not all the newly-built houses succeeded to satisfy their inhabitants. A recent article in an Indonesian daily newspaper, *Kompas*,[8] mentioned that, in some districts, the occupants became so disappointed in their new houses (which cost about 4,000 Euro/unit) that they preferred to find shelter again with their relatives, or to move back to their barracks. Some are even renting out their houses to construction workers from outside the district.

This disappointment, which leads to rejection of the houses, is due to the poor quality of the houses; to mention a couple of complaints: within six month of occupation, the wooden parts were already attacked by termites and mice; the roofs and walls are not water-tight, allowing rain water to penetrate. The occupants ended up having to make expenses in order to repair or renovate their houses.

The same article mentions that according to the developers, the faults lie with the occupants who are considered too demanding, while according to the occupants, they hardly had any involvement in the design and construction process. Considering the magnitude of the damage and impacts caused by the Tsunami, it is indeed not an easy job to provide mass housing for all displaced people at once, causing most of the funding agencies to choose the 'house for people' approach rather than to build *with* people. However, it is clear that in this case, the village development team (*Tim Pembangun Kampung*/ TPK) and community's representatives have not carried out their job properly. At the same time, the people (or potential occupants of the new housing) had no means to supervise the process, because they were positioned as charity-receivers, who had no choices concerning their future homes. This incident illustrates how a lack of communication among actors who are involved in a housing project and a lack of involvement of the inhabitants, can cause major failures in an important and urgent housing project.

Another example of a mass housing project, which also had to be completed very quickly (due to political expediency), where occupants did not get the time or occasion for the process of adjustment, is described in Janssen (2000). Janssen, who visited the site after some months of the inauguration, observed that a house owner let pieces of glass from a broken window lie scattered on the floor. It turned out that, three weeks before, a rooster flew into the house through the window like it was accustomed to in the old house. It was evident that although the house was legally the property of the occupants, the sense of ownership had not taken root yet in their minds. Otherwise, they would have repaired the window or at least cleared the broken glass pieces.

The examples prove that it is essential to induce effective communication among all parties involved in a design project: producer, manufacturer, users (in this case: housing occupants), investors, etc. However, it is not a simple task to relay messages among these actors, due to their different

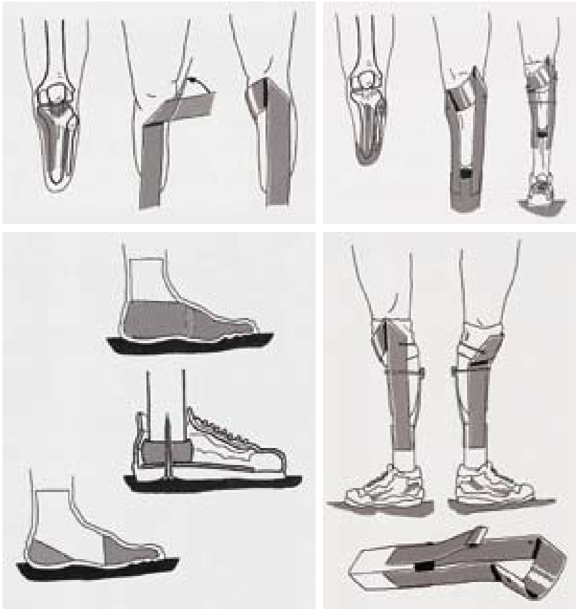


Fig. 1.1 Prosthesis for Cambodia by Inne ten Have

backgrounds, perspectives and priorities, and often also due to limitation of time and financial resources. Therefore, a communication device that can assist during the discussion sessions among the parties is crucial. The following cases present successful examples of such a communication device for industrial products: a prosthesis manual for Cambodean people and guidelines by *DemoTech*.[9]

The first example is a graduation project of Inne ten Have, a student at the Industrial Design Academy in Eindhoven (now Design Academy Eindhoven).[10] He worked on a new solution for the supply of prosthesis in Cambodia from the conviction that the value of a prosthesis does not merely lie in the material, but also in the ability of the patients to help themselves. His project was motivated by the fact that, previously, the prosthesis that were distributed to Cambodian people whose legs had to be amputated (due to land mines that were spread in rural areas since the Pol Pot regime in 1974-1979) were donations from foreign countries, which however did not succeed in achieving their virtuous goal.[11] His project, which was inspired by the ideas and works of Victor Papanek and David Werner (both share a belief that (health)care for all is only possible if man shapes his own tools and environment), resulted in a design for a prosthesis made of local, affordable materials. This prosthesis can be made and maintained by the Cambodian people themselves, which can be adjusted to fit their physical conditions. Most importantly, he produced an illustrated manual of his prosthesis design which functions as a guideline that can be understood easily by Cambodian patients and prosthesis makers.

The next example is a series of guidelines and manuals that were produced by DemoTech, an organization that started its activities in 1970, by participating in a FAO-congress in The Hague, The Netherlands.[12] Demotech, with the slogan ‘design for self-reliance’, supports the application of technology that can reach all who need it, as shown by its first design: a hydraulic ram pump that can be constructed locally. Since its establishment as a foundation, in 1979, Demotech has been producing numerous guidelines and manuals for intermediate yet innovative technology that can be applied easily anywhere, especially in rural areas. All Demotech design and guidelines are obtainable from their website (http://www.demotech.org), mainly in the form of clearly illustrated manuals that can be easily understood and applied by the aimed users. Their website welcomes comments, input and any other

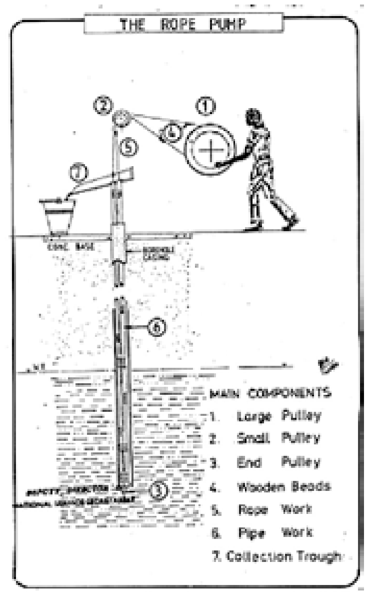


Fig. 1.2 First page of the Rope Pump construction manual by Demotech

form of participation from its visitors, in order to broaden the knowledge for the benefit of as many people as possible.

These experiences show a method to involve people actively in designing, manufacturing, using and maintaining products for their own needs; by using a communication tool in the form of an illustrated manual or guideline. This type of tool is particularly helpful when discussing a design or plan with common people who are not familiar with engineering terms, but are partly the executors of the project and the end users of the product. In the long run, projects that provide self-built facilities such as these examples are most likely to be continuous, since the people possess the skills to produce and maintain their own facilities.

This research proposes that this method of conducting a project provides a successful approach for a sustainable practice:

- acknowledge skills and capacities of the local community
- attempt to discover local solutions
- make use of local materials and resources as much as possible
- stimulate community involvement and a feeling of ‘ownership’
- allow community participation[13]

It is feasible to apply a similar method to a housing scheme, especially to avoid cases that were mentioned previously, where lack of involvement by inhabitants has resulted in undesirable houses and an unattached feeling of the inhabitants towards their houses (consequently disregarding the maintenance). In the case of housing projects in Indonesia, the method should also be applicable to densely populated areas. This research looks into an effective method to conduct successful, sustainable building projects in Indonesia, by presenting current practices in Java,[14] the most populated island of Indonesia.[15]

CONCLUDING REMARKS

- This research was inspired by the idea to view housing development as a process that may improve environmental quality, instead of causing environmental deterioration, through the implementation of a sustainable housing practice.
- This research regards human individuals and communities as a major consideration in the building process. Unlike other studies of similar subject that prioritize the physical aspects of the housing process, in this research the inhabitants are put in the foreground, who actually are the main executors of housing activities and determine the success of a sustainable housing project.
- This research puts forward solutions that can be executed locally, considering that the use of local (natural and human) resources will not only minimize environmental impact, but will also secure maintenance and create a sense of belonging towards the facilities.

Existing housing policies and regulations are theoretically ideal for the current conditions of Indonesian urban areas. However, it is difficult to successfully execute these regulations, because, on the one hand, there is lack of control from the government and authorities. On the other hand, there is lack of discipline in dense urban areas. The urgent need for shelter often forces people to evade the regulations – which commonly requires elaborate formalities – or even to set up illegal settlements. In order to cope with this unfavorable situation, and considering the above conclusions, this research concurs that the most effective method to create sustainable housing is through the initiative and motivation of the residents themselves in taking proactive actions for the benefit of their own domestic environment.

PHILOSOPHY

As mentioned previously, this research assumes the following items to be prerequisites for achieving sustainability in the a built environment:

- acknowledge skills and capacities of the local community
- attempt to discover local solutions
- make use of local materials and natural resources as much as possible
- stimulate community involvement and a feeling of 'ownership'
- allow community participation

In short, encourage active participation in housing development from the (potential) inhabitants, who will occupy the facilities, in order to achieve a sustainable domestic environment.

This insight is not new. For example, Prahalad (2004) argues that his Bottom of Pyramid (BoP) approach (by banks, companies, etc. who accomodate the financial needs of the poorest) *'to create opportunities for the poor by offering them choices and encouraging self-esteem'* can minimize the financial burden in developing countries. Furthermore, Prahalad states that the economic potential of people at the 'bottom of pyramid', or those of the lowest income group, should be recognized. Prahalad, however, proposes to see these people as consumers, or a 'new' market opportunity, from which profit (for all parties, he argues) can be made by providing them affordable products and services. The latter is not fully in accordance with the notion of this research, which does not regard inhabitants as mere consumers of their dwellings, nor emphasizes financial contribution as the main form of the inhabitant's participation in a housing project.

Concerning this matter, another theory is deemed more favorable. Schumacher's 'Buddhist Economics' (1973), as opposed to modern economics, *'give a man a chance to utilize and develop his faculties, enable him to overcome his ego-centredness by joining with other people in a common task and bring forth the goods and services needed for a becoming existence.'* The prospective of 'Buddhist economics' furthermore proposes the principle of production from local resources for local needs, and distinguishes the use of renewable materials as the most rational way of economic life.

In *Tools for Conviviality* Illich (1974) states: *'... most people do not feel at home unless a significant proportion of the value of their houses is the result of the input of their own labour'*. In addition, Illich noted that systems and regulations prevent common people from doing that. Housing or urban-renewal projects, which are commonly proposed by the city, indeed often include 'citizen participation'; nevertheless, after the public hearing the final decisions are made by the officials in power. This process has resulted in a situation where the inhabitants find themselves *reacting to* existing conditions rather than being able to initiate their own. In coping with this situation, Goodman (1972) recommended that people should begin the process of change (towards a more humane living environment) themselves, instead of waiting for governments, officials, developers and other organizations to meet their demands. Furthermore, Goodman concluded:

> *'To create a condition in which people can act on their own environmental needs, in which they can make the distinction between the expert's technical and aesthetic judgments, requires a change in the consciousness of both the people and the experts. It requires that people develop the willingness to design the form of their environment, to live in it, to adapt it to their needs. At the same time, the expert can accelerate this process by changing his traditional approach to architecture. Instead of an insistence on designing all buildings, as many architectural leaders have aimed at [...], we would begin to demystify the profession'.*

An example of a self-developed settlement is Village Homes (consisting of 244 single- and multi-family residences on 60 acres) in Davis, California, which was designed and developed by Michael and Judy Corbett in the 1970s (Francis, 2003). In this community sustainability is visually evident through community spaces such as common areas, gardens and green space. However, in the first phase of the process, the concept of Village Homes was met with considerable resistance and hostility by the city officials (Judy Corbett: *'The policeman did not like the dead-end cul-de-sacs, the fire department did not like the narrow streets, the public works department did not like agriculture mixing with residential'*). Financing the project was also difficult (*'We went to 30 different banks before we got a loan'*); the reasons given by the banks included lack of past experience as developers and the unusual aspects of the plan. These obstacles show that an unconventional idea of letting people build their own settlement is not easily accepted by the local officials.

Nevertheless, the initiators – the designers and developers, who also live in the neighbourhood – finally did manage to build Village Homes, where the neighbourhood thrives and succeeds to achieve recognition as a sustainable community. The success of Village Homes is due to *'the strength of the sense of community and the feeling of belonging to a neighbourhood'*. Although not entirely free from problems and criticism, Village Homes is remarkable for its success factors, among others participation, emphasis on open space, communal space, emphasis on pedestrians and cyclists first (cars second). It demonstrates how *housing* is not merely a product or a tangible entity, but more an activity and a process towards a desirable lifestyle of the community.

Javanese philosophy sees a house as a socio-cultural phenomenon rather than economic commodity. 'House' is *omah* in Javanese language and *rumah* in Indonesian language. *Omah* is among the most essential symbols of existence for a Javanese; the term *pomah*, or 'how to achieve happiness at home', becomes an important keyword. A unification of two individuals, or marriage, is called *omah-omah* (in Javanese) or *berumah-tangga* (in Indonesian), the wife is called *somah* or *sa-omah* (in Javanese, meaning 'living in the same house'). Y.B. Mangunwijaya, a renowned Javanese architect and former priest, looked at architecture not merely as an outer skin, but as an inner spirit which, in the end, should provide freedom for people to express themselves through their living space. The Javanese philosophy concerning housing and the direction of the Village Houses community are in accordance with the propositions of this research. These concepts become the main philosophy of this research

Fig. 1.3: Map of Indonesia

in setting directions towards a sustainable living environment. Based on this support, the research objectives are formulated in the next section, followed by research questions and research methods.

1.2 Focus of Research

In this research the role of public participation and local capacities and resources in housing development are acknowledged. Focusing on the housing conditions in Indonesia, the scope of this research is limited to the subject of residential housing, with the aim to apply the concept of sustainable housing in dense urban areas. This chapter presents research objectives and research questions, which are followed by research methods that explain the structure of this dissertation.

OBJECTIVES AND RESEARCH QUESTIONS

This research aims to:

- Define 'sustainable housing' for Indonesian conditions
- Determine the current levels of sustainable housing implementation in Indonesia
- Look into an example of an Indonesian indigenous resource that can serve as an element for sustainable housing: bamboo as an alternative building material.
- Produce a communication tool that can help motivate and rouse interest of inhabitants to be actively involved in improving their own domestic environment.

Concepts and theories of sustainable building and various sustainable building projects have been explored and carried out, mostly in developed countries. The main ideas of 'sustainable housing', however, can be adapted to any geographical situation. Indonesia requires appropriate strategies, relevant to its hot-humid climate (due to its location on the Equator, see Fig. 1.1), in order to create a sustainable domestic environment. The *main research question* of this dissertation is:

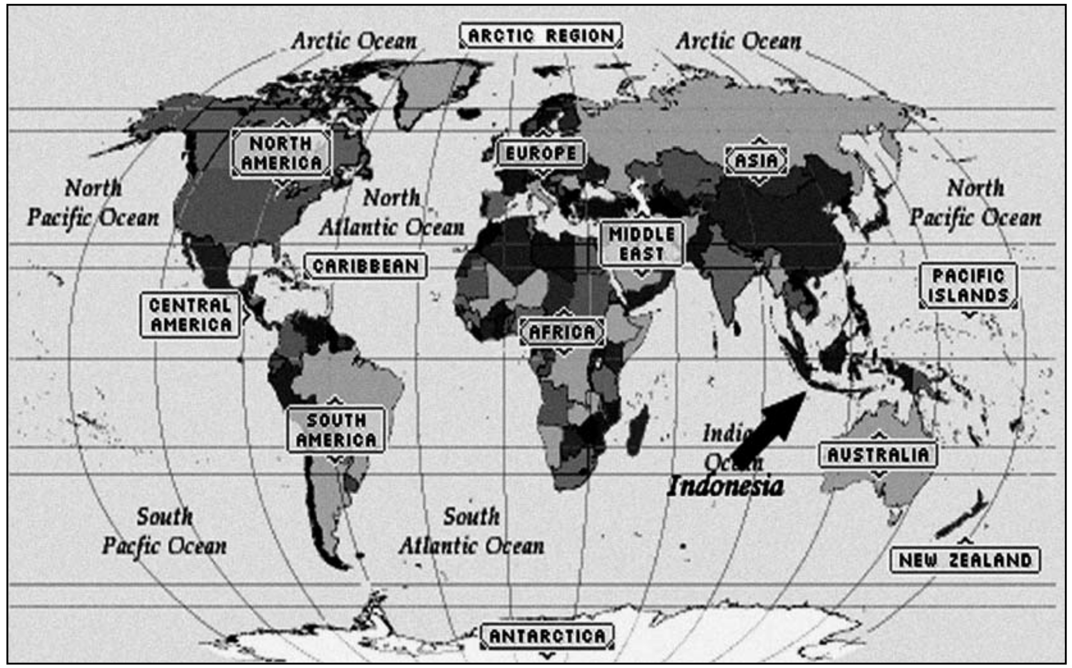


Fig. 1.4: Position of Indonesia in the world / Source: http://www.infoplease.com/atlas

HOW CAN THE CONCEPT OF SUSTAINABLE HOUSING BE IMPLEMENTED IN INDONESIA?

In order to answer this question, several subjects should be defined in advance, through the following research questions:

RESEARCH QUESTION 1

What constitutes sustainable housing in Indonesia?

- What is the background of sustainable housing?
- What are the existing concepts of sustainable housing?
- What are the specific characteristics for housing in Indonesia?

RESEARCH QUESTION 2

How can the levels of sustainable housing be determined?

- What parameters and qualification systems can be used?

This research focuses on one sustainable building aspect, *material*, as an implementation example. Bamboo, an abundant natural resource that has been utilized as a building and construction material for centuries, is presumably the most prospective option for an alternative building material for sustainable housing in Indonesia.[16]

RESEARCH QUESTION 3

How sustainable is bamboo as a building material in Indonesia?

Table 1.1 The Empirical Cycle and the Regulative Cycle

EMPIRICAL CYCLE	REGULATIVE CYCLE
Theoretical Problem Description/interpretation	Practical Problem Bigger role of clients Description/interpretation
Induction/Hypothesis Analyze situation within a boundary Generalization Modelling Clarification/interpretation	Diagnosis (initial functioning) Generalization Modelling Design
Theory (problem solving) Modelling Analyze effects	Plan Providing possible practical goals and solutions Decisions Choose goal and specify the means
Deduction Predicting Observing	Intervention Action or process support Following changes (according to measurements)
Test Measure effective intervention	Process Evaluation Intervention during implementation
Evaluation	Product Evaluation Effectivity & efficiency intervention

Overview of aspects specific to the empirical and regulative cycles. Correlation between Empirical Cycle type research (conventional) and Regulative Cycle type research (applied) (Christiaans et al., 2004)

1.3 Research Methods & Research Scheme

RESEARCH METHOD

In order to achieve sustainable housing, one possibility is to apply improved or advanced technology (i.e. photo voltaic electricity, energy-saving light bulb, water purifier), mainly intended to control input and output of energy and resources during the whole building process. However, economic and social-cultural issues, which also play an important role, should be included in the discussion of sustainable housing, especially for the situation in Indonesia. Therefore this research examines the interrelations between technical, economic, ecological and social factors in housing development in Indonesia; it integrates various knowledge disciplines, which are relevant to the subject of sustainable housing. This research combines fields of natural science and applies them to practical problems, which classifies it as *applied research*.[17]

This research aims to perform an analysis of the technological, economic and social development with respect to different aspects (energy, water, materials, etc.), in order to identify common features and interrelationships. These common features and interrelationships then serve as the basis for the development of generic approaches and methods for users and policy makers, in the form of sets of requirements, guidelines and recommendations, meant to support policy making and future housing development in Indonesia.

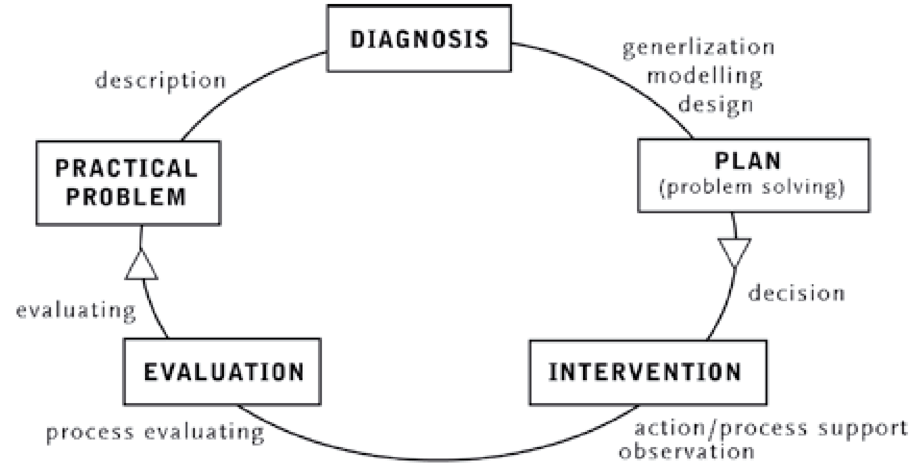


Fig. 1.5: The Regulative Cycle for applied research (Christiaans et al., 2004)

The goal of applied research is not only to explain facts as adequately as possible, but moreover to be able to predict their effects and consequences more precisely, and to make them more applicable. In practice, the border between fundamental and applied research can not always be drawn sharply. Applied research can easily be paired with the generating of new, fundamental research questions. In reverse, fundamental research often leads to practical applications in the short term.

This research falls into the *Regulative Cycle* research type (See Table 1.1), due to the nature of its process, starting with a practical problem (applying sustainable building concepts to a real situation in Indonesia), which includes a diagnosis (of measuring tools) instead of proposing a hypothesis; and presenting a plan (referring to existing examples of sustainable practices, which are analyzed through an intervention) before coming to the evaluation phase.

In elaboration, the six phases of this research, according to the Regulative Cycle, are:

- *Practical Problem* (description/interpretation): This part consists of general descriptions of sustainable development and sustainable housing, which form the background of this research; formulation of research questions; and inventory housing conditions and problems in Indonesia.

- *Diagnosis* (generalization, modeling, design): This part consists of the identification of (measurement) methods that are relevant to the research questions, which will be used to formulate the definition of sustainable housing in later chapters.

- *Plan* (choose goals and specify the means): This part presents existing cases which are presumed to be the current practice of sustainable housing in Indonesia, which are later on referred to in the formulation of sustainable housing requirements for Indonesia.

- *Intervention* (action or process support): This part consists of an analysis of existing cases and the formulation of a set of requirements and guidelines for Indonesian sustainable housing, based on the analysis.

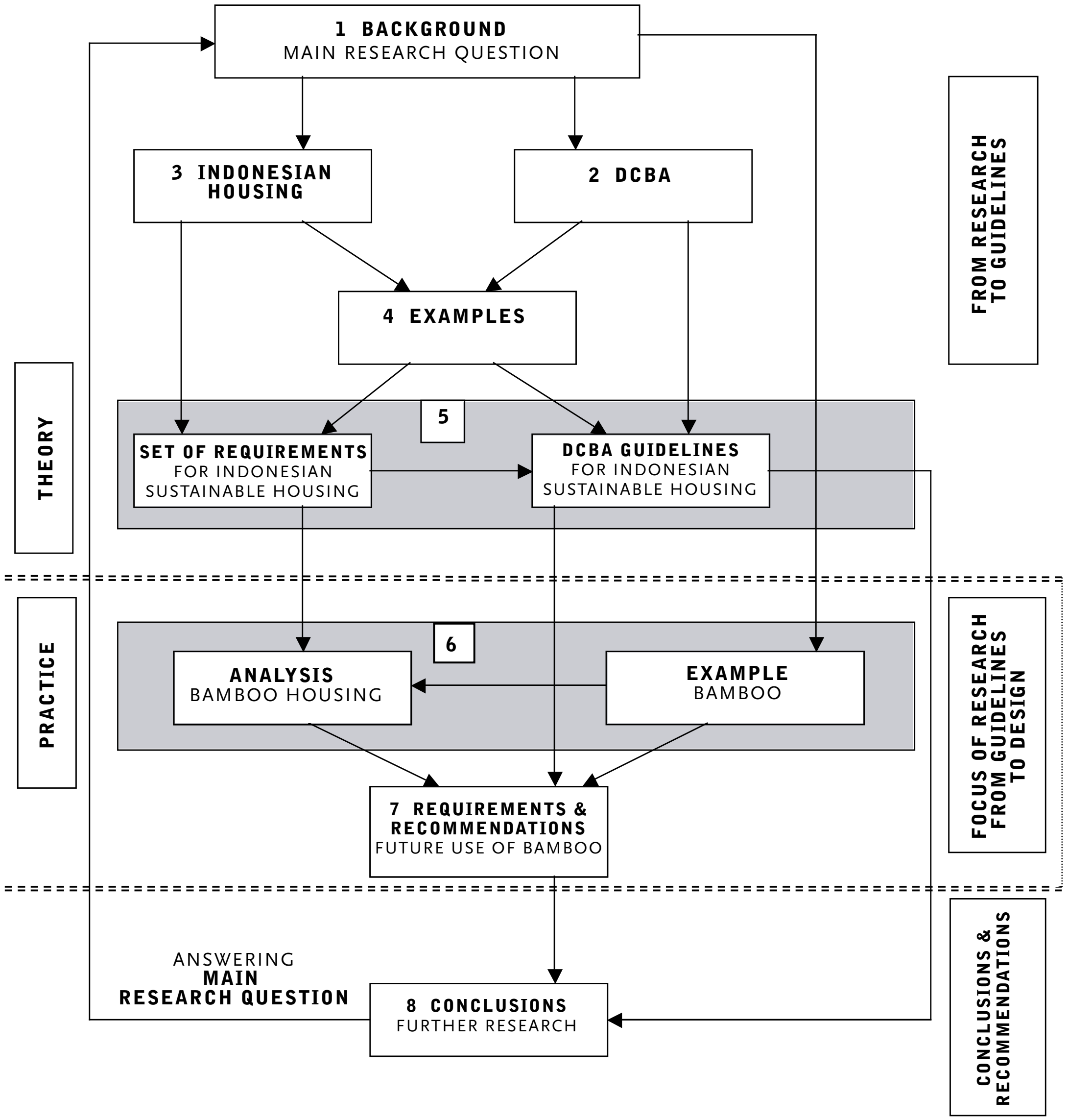


Fig. 1.6: Research Scheme: diagram of the research flow for applied research (Christiaans et al., 2004).

- *Process Evaluation* (intervention during implementation): This part provides an implementation of the previous results (the set of requirements and guidelines) using one sustainable housing aspect ('material'), focusing on bamboo, which is presumed to be an appropriate option for a sustainable building material for Indonesia. Existing examples of bamboo buildings are presented.

- *Product Evaluation* (effectivity & efficiency intervention): This part consists of an analysis of the examples; an adaptation of the principles to the situation in Indonesia and a formulation of its feasibility in Indonesia.

The phases, corresponding to the chapters of this dissertation, can be elaborated as follows: phases 1-4 (from Practical Problem to Intervention) constitute the theoretical part of this research: from *Research* to *Guidelines*; phases 5-6 (Evaluation) are the practical part of this research: from *Guidelines* to *Design*. The research cycle loops through the final phase, *Conclusions & Recommendations*, which, in addition to answering the research questions, also provides new (practical) problems. The flow of these research phases that corresponds with the chapters can be visualized as in the scheme in Fig. 1.4.

(1) PRACTICAL PROBLEM

This research was started by conducting literature studies, especially in order to acquire data from respectable institutions and resources in the subjects of sustainable development and sustainable housing, in order to find fundamental concepts and descriptions concerning sustainable housing worldwide. These collected data form the background of this research, support the motivation of this research and are referred to in the formulation of the research questions (Chapter 1.2).

(2) DIAGNOSIS

The literature study was also conducted to find concepts of sustainable development and theories and standards of sustainable housing (Chapter 2), in order to set definitions and parameters that are used throughout the dissertation. The literature which was consulted for this chapter mainly comes from the field of architecture and building science with ecological subjects. These references were useful to identify (measurement) methods to be used to formulate the definition of 'Indonesian sustainable housing' in later chapters. The literature study also had the purpose of gathering statistics concerning housing needs and housing development in Indonesia (Chapter 3.1), with the Indonesian Central Bureau of Statistic as the main source. Further literature studies were aimed at finding out the history and data concerning traditional Indonesian communal activities (Chapter 3.2); which led to a social-anthropological reference and contributed to the set of Indonesian sustainable housing requirements.

(3) PLAN

The next step of this research involved field studies, which included visits to locations of cases which are presumed to be the current practice of *sustainable housing* in Indonesia (Chapter 4), where the researcher gained first-hand impressions. This field study also involved interviews and discussions with experts in Indonesian housing issues. This part of the research took place in Indonesia. The interviews and discussions were mainly held in academic, research and governmental institutions (i.e. the architecture or urban planning departments in universities, Department of Public Works, Housing and Facilities Planning Research Center, Agency for Science and Technology Development and the Environmental Impact Agency). The same chapter includes an analysis of each example, based on the assessment methods that were introduced in the previous chapters (sustainable housing aspects and DCBA).[18] Conferences and seminars have been very useful to get input and feedback concerning the subject of sustainable housing; input from people with different knowledge backgrounds could be gathered. Some sub-chapters of this dissertation (Chapter 3.2, Chapter 4.1 until 4.4 and Chapter 6.1) are actually derived from papers presented at these events. Moreover, the most updated version of relevant knowledge disciplines has been acquired from networks that were built during the research process, which will also be useful in the future.

(4) INTERVENTION

The analysis and assessment of all the data, lessons learned and considerations taken from the existing examples in Indonesia, resulted in a set of requirements and a guideline for Indonesian sustainable housing (Chapter 5). Chapters 1 to 5 present the theoretical part of this research, while the following chapters (Chapter 6 and Chapter 7) demonstrate an implementation of the methods proposed in Chapter 5 as an example. For this purpose, bamboo is chosen being one of the building materials that is considered to be a good option for usage in sustainable housing in Indonesia.

(5) PROCESS EVALUATION

Literature studies were again conducted in order to gather data about bamboo and the history of its usage in Indonesia as a building material. This introduction to bamboo includes various aspects: taxonomy, preservation (methods and chemical substances) and production techniques. Examples of bamboo housing projects (in Yogyakarta, Costa Rica, Ecuador and China) are presented as considerably successful projects; experiences which can be of benefit for Indonesia (Chapter 6). As the conclusion, this chapter presents an analysis of the examples with bamboo as a building material, implementing the previous results of the research (the set of requirements and guidelines of Indonesian sustainable housing).

(6) PRODUCT EVALUATION

Data about bamboo from the previous chapter were used to investigate the feasibility of the use of bamboo as a sustainable building material in Indonesia in the future. Consultation with an expert in bamboo building and design was conducted for this particular subject. The analysis has resulted in a set of requirements for the utilization of bamboo as an industrial building material and its impacts on other aspects of sustainable building (Chapter 7). Consultation of tutors during the completion of this research was done intensively, where most of the workload consisted of evaluating, analyzing and formulating conclusions and recommendations, which are compiled in the final chapter (Chapter 8) of this dissertation. This final chapter aims to conclude the research by answering the main research question and presenting recommendations for further investigation (providing new research problems/questions for further research).

Notes

1. *'The autonomous house on its site is defined as a house operating independently of any inputs except those of its immediate environment. The house is not linked to the mains services of gas, water, electricity or drainage, but instead uses the income-energy sources of sun, wind and rain to service itself and process its own wastes.' – Vale and Vale, 2000.*

2. *The garbage dump, in Leuwigajah, received about 5,000 tons of garbage daily from three areas, Bandung municipality and regency as well as Cimahi city. There were six million cubic meters of garbage in the 23.5-hectare dump with an average height of 20 meters (source:* Jakarta Post, *February 22nd, 2005, accessible at http://www.thejakartapost.com/detailweekly.asp?fileid=20050222.@01)*

3. *Extraction has reached almost 50% of the groundwater reserve, while a safe number is between 20-30% (source:* Kompas, *July 1st, 2006, accessible at http://kompas.com/kompas-cetak/0606/01/humaniora/2690467.htm)*

4. *As opposed to the* cradle-to-grave *way of thinking, which sees products as 'ending their lives' and becoming 'disposable waste' when they have reached the final phase of their service or function (i.e. by being broken, overused, or outdated).*

5. *Source: ICSID website, accessible at http://www.icsid.org/about/Definition_of_Design/*

6. *Source: IDSA website, accessible at http://www.idsa.org/webmodules/articles/anmviewer.asp?a=89&z=23*

7. *Current census data indicate that some 192,000 people still identify themselves as internally displaced persons, of which 115,000 are still accommodated in tents or barracks. Source: website of* Badan Rekonstruksi dan Rehabilitasi/BRR Aceh-Nias *(the Reconstruction Agency for Aceh and Nias), accessible at http://www.e-aceh-nias.org/index.php?id=indicators_main.html*

8. *'Hilangnya Peran Komunitas dalam Desain Rumah',* Kompas, *7 May 2006, http://www.kompas.com/kompas-cetak/0605/07/desain/2598720.htm. A relevant article from* Kompas, *12 April 2006: 'Rumah Bantuan Oxfam Terbengkalai dan Ditinggalkan Warga', http://kompas.com/utama/news/0604/12/221430.htm*

9. *DemoTech – the name is derived from 'Democracy supporting Technology' – is a foundation which' activities concern the application of intermediate technology, while maintaining ecological and cultural values.*

10. *Source: Inne ten Have,* Afstudeerverslag beenprothese Cambodja, *http://www.xs4all.nl/~inne/nl/beenprot.htm*

11. *The prosthesis provided by Western aid organizations were based on western designs but were made of cheap plastic to minimize expenses, and were supposed to last for two years (while the Cambodian patients used them all their lives); they were given away for free without any physiotherapic assistance, therefore the prosthesis did not fit properly and ended up being disassembled and sold as separate parts by the patients; the users of these prosthesis still ended up being dependant on the imported material, production technique and foreign money.*

12. *Reinder van Tijen, a construction engineer whose work and ideas support the concept of 'technology within poverty', participated in the Second World Food Congress of FAO (Food and Agriculture Organization of the United Nations) in The Hague in 1970, on behalf of DemoTech, a foundation that was first introduced on that occasion.*

13. *Common people may have only limited or no expertise and knowledge about the technical or engineering aspects of the project, therefore their input in these aspects may also be limited. However, they have basic needs and wishes that should be accommodated properly.*

14. *Considering that almost all of the existing cases and experiences are located in Java, the subtitle of this research refers specifically to Java. Being the most populated island of Indonesia, Java is faced with more complicated problems compared to the other islands of Indonesia (Silas, 1989). These complications also reflect to housing issues, which lead to an expectation that the investigation and results of housing experiences in Java in this research are applicable to most regions of Indonesia and other countries with similar conditions.*

15. *The Population census of 1961 recorded that Java was inhabited by 63,1 million people, or 64,95% from the whole Indonesian population. The surface of Java Island itself is only 6,89% of the total surface of islands in Indonesia (Silas, 1989).*

16. *For the greater part of Indonesia, and especially for Java with its high population density, bamboo – being a dominating indigenous material in Indonesia – is by far the most important traditional building material, compared to other organic materials i.e. coconut fibers and ramie waste (FAO, 1956). It is also one of the oldest materials used in building construction; a good substitute for timber (Purwito, 1995).*

17. *Applied research is the discipline dealing with the art or science of applying scientific knowledge to practical problems. Source: http://wordnet.princeton.edu/perl/webwn*

18. *The DCBA method is elaborated in Chapter 2.3.*

People participation, from planning to implementation, in an urban quality project in Mataram, Nusa Tenggara Barat / Photo: NTVET GTZ / Source: Paving the Way for Sustainable Development in Indonesia. *2002, p. 46*

2. SETTING PARAMETERS & DEFINITIONS

This chapter discusses the derivation of *sustainable building* from the concept of *sustainable development*, the addition of 'P' for 'Project' – as a specific process in the subject of *built environment* in Sustainable Development – to the 'Triple Ps' (People, Prosperity and Planet) and an introduction to the DCBA System, an instrument that is used for measuring the level of sustainability of the cases treated in this dissertation.

2.1 Definition of Sustainable Building

FROM SUSTAINABLE DEVELOPMENT TO SUSTAINABLE BUILDING

The most frequently quoted definition of 'sustainable development' is: *'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'*.

It is derived from *Our Common Future*, a report published by The World Commission of Environment and Development (known also as the Brundtland Commission) in 1987. This concept has received continuous attention since then and in 1992 the United Nations Conference on Environment and Development produced The Earth Summit, or 'Rio',[1] which led to the formulation of an action plan, Agenda 21.[2] Chapter 7[3] (Section Social and Economic Dimensions) of Agenda 21 is about promoting sustainable human settlement development, of which program areas include:

- providing adequate shelter for all
- improving human settlement management
- promoting sustainable land-use planning and management
- promoting the integrated provision of environmental infrastructure: water, sanitation, drainage and solid-waste management
- promoting sustainable energy and transport systems in human settlements
- promoting human settlement planning and management in disaster-prone areas
- promoting sustainable construction industry activities
- promoting human resource development and capacity-building for human settlement development

Following the Earth Summit in Rio, the World Summit for Sustainable Development was held in Johannesburg in 2002. Points about energy and sanitation, which are relevant to the sustainable building issue, were included in the key outcomes of the summit.[4] Under the key commitments, targets and timetables of the summit, water and energy issues are mentioned:

WATER AND SANITATION

- Halve the proportion of people without access to safe drinking water by the year 2015 (reaffirmation of Millennium Development Goal).
- Halve the proportion of people who do not have access to basic sanitation by the year 2015.

ENERGY

- *Renewable energy*. Diversify energy supply and substantially increase the global share of renewable energy sources in order to increase its contribution to total energy supply.
- *Access to Energy*. Improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services and resources, sufficient to achieve the Millennium Development Goals, including the goal of halving the proportion of people in poverty by 2015.

- *Energy Markets*. Remove market distortions including the restructuring of taxes and the phasing out of harmful subsidies. Support efforts to improve the functioning, transparency and information about energy markets with respect to both supply and demand, with the aim of achieving greater stability and to ensure consumer access to energy services.
- *Energy efficiency*. Establish domestic programs for energy efficiency with the support of the international community. Accelerate the development and dissemination of energy efficiency and energy conservation technologies, including the promotion of research and development.

Along with these collective efforts to create a better future, in order to translate the conference results into reality, numerous theories, guidelines and tools have been implemented in developed countries. Among others:

Green Building Manual from the US Department of Energy (DOE) & Public Technology, Inc. (PTI),[5] which includes the following points:
1 Site Issues: selection of building sites, landscaping, watershed, site materials and equipment
2 Building Design: building systems (heating, ventilating, air-conditioning, electrical and plumbing systems) and indoor environmental quality
3 Construction Process
4 Operations & Maintenance
5 Economics & Environment: energy and water efficiency, waste reduction, construction costs, building maintenance & management savings.

In their book, *Green Architecture*, Brenda and Robert Vale (1991) list the following principles:
1 Conserving energy: to minimize the need for fossil fuels to run it
2 Working with climate: to work with climate and natural energy resources
3 Minimizing new resources
4 Respect for users
5 Respect for site: 'touch-this-earth-lightly'
6 Holism: holistic approach to the built environment

A consulting firm in the USA, Building Environmental Science & Technology (B.E.S.T.), formulated residential 'green building' guidelines:[6]
1 Emphasize the four 'R's: reduce, recycle, re-use, renewable
2 Use energy, water and resource efficiently: design, specification and construction methods
3 Healthy indoor air quality
4 Building has 'affordable' community: location and connectivity with accessible public transport, etc.
5 Development creates a sense of well-being: neighbourhood, community
6 The home remains reasonably affordable and cost-effective

The following environmental themes (Blaauw, 1997) are derived from a workbook for sustainable building and housing:
1 Energy
2 Use of materials
3 Water
4 Disposal
5 Site
6 Green
7 Traffic
8 Outdoor environment
9 Indoor environment

From the above list, it can be seen that interpretations of the UN declaration have resulted in various forms of regulations, guidelines, concepts, etc. for different conditions. However, they are aiming at similar points: eco-efficiency (including the use of energy and materials) while some also put more emphasis on the well-being (health, wealth, comfort) of the inhabitants.

For the purpose of this research, seven aspects of sustainability that can be used to analyze sustainable housing in Indonesia, were derived from the six environmental themes that are distinguished *The National Measures for Sustainable Building* (Hendriks, 2001):

ENERGY
- Reducing the demand for energy
- Promoting the use of sustainable energy resources
- Using energy efficiently

MATERIALS
- More efficient use of materials
- Reducing waste and removing it responsibly

WATER
- Reducing water usage
- Preventing land drying up
- Protecting water quality

INDOOR ENVIRONMENT
- Improving air quality
- Improving thermal comfort
- Reducing noise levels

SURROUNDING ENVIRONMENT
- Supporting bio-diversity
- Strengthening the perception of the environment (including maintaining old townscapes)
- Reducing nuisance (noise, wind, odor)

MISCELLANEOUS
- Improving the flexibility of the home with regard to accommodating new functions
- Improving safety

These aspects of sustainable building measures are limited to the environmental aspects of sustainability, while in the case of Indonesia, economic and social-cultural aspects play an important role in housing development as well. Therefore 'Miscellaneous' is substituted by two aspects that are essential for the situation in Indonesia: *economic* and *social-cultural* (see Chapter 3 for the arguments concerning these additional aspects).

As a concluding remark, a general definition of 'sustainable building' is: Sustainable building results in buildings that are designed and constructed with high ecological standards (especially in minimizing waste and negative environmental impacts, and efficient use of energy, water and material resources), that are within the economic means of the occupants and promote their well-being.

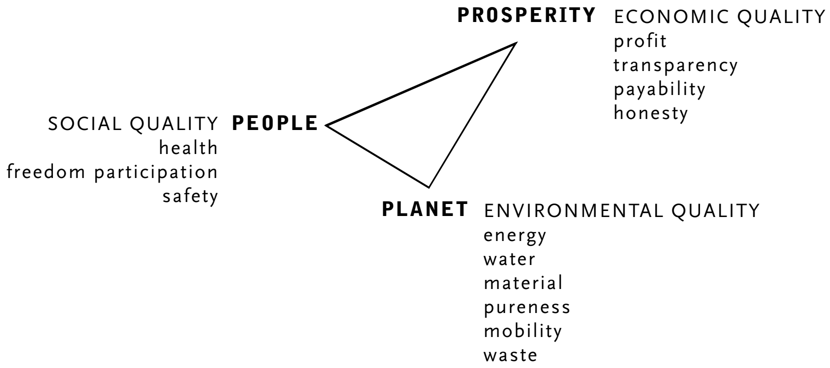


Fig. 2.1: Triangle for Triple P: People, Planet and Prosperity.

2.2 Introduction to the Quadruple P

This section discusses the correlation between the three areas of sustainable development (People, Planet and Prosperity) and built environment (Project), in order to explain the position of sustainable building within the scheme of sustainable development.

PEOPLE, PLANET, PROSPERITY

Sustainable development as proposed by the UN looks broadly at three areas: *People*, *Planet* and *Prosperity* (the term *Prosperity* has replaced *Profit* – which was used earlier by the UN – since the Earth Summit in Johannesburg, 2002).

- *People:* Increased prosperity and a good environment should benefit everyone. Problems like access to services, social exclusion, poverty, poor housing, unemployment and pollution must be tackled. We must not treat others in the world unfairly.
- *Planet:* Threats to the environment include climate change, air quality, toxic chemicals, species extinction and habitat destruction. Sustainable development must address these problems. This means using resources like oil and gas efficiently and developing alternatives to replace them.
- *Prosperity:* Economic growth generates increased prosperity. Businesses must produce high quality goods and services to satisfy consumers throughout the world.

These three Ps (*People*, *Planet*, *Prosperity*) stand for social quality, environmental quality and economic quality. For social quality, related aspects are: safety, freedom, livability and participation. Environmental quality is characterized by the flows of energy, water, material, goods, traffic and waste, which are employed by buildings, neighborhoods and cities. Economic quality recognizes, apart from profit, aspects such as transparency, affordability and honesty.

Particularly for design projects or the built environment a fourth P – for *Project* – which represents design quality is added to the triangle of sustainable development (van Dorst & Duijvestein, 2004). This includes the aspects of beauty, robustness, (bio)diversity and relations through scales. The triple P can be placed in a triangle; with the additional P for *Project* the triangle is changed into a tetraeder (see Fig. 2.2).

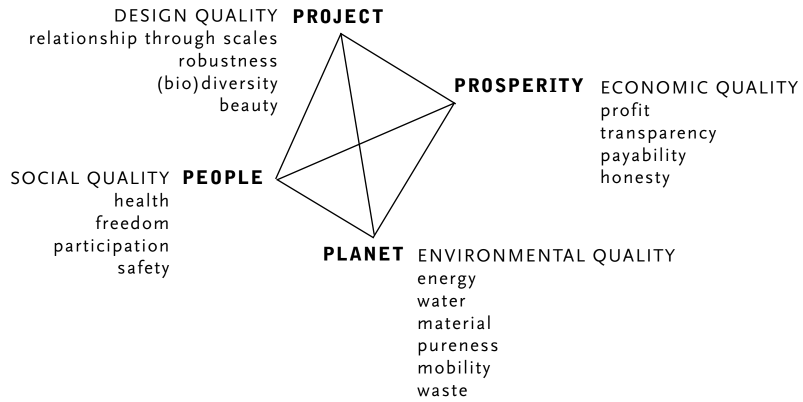


Fig. 2.2: Tetraeder for the Quadruple P: People, Planet, Prosperity and Project

The tetraeder can be used to show the importance of and the relations between the four qualities. The most important quality can be placed at the top and in all cases it has to be based on and supported by the three others. This tetraeder can also be used to show how a part of one P can influence the other P's. In this dissertation, it will be shown in Chapter 7.2 that the use of bamboo as a building material (under P for *Planet*) is interconnected with the other P's (*Project*, *People* and *Prosperity*).

Fig. 2.3 shows the connection between sustainable development and sustainable building. The idea of sustainable development, which covers the area of Planet, People and Prosperity, becomes the basic motivation of action plans in different fields. In the field of the Built Environment, *Project* is added to the existing Triple P of Sustainable Development (Planet, People and Prosperity), based on the fact that the design factor also determines the sustainability level of a manufacturing or building process. One of the products as an output under Built Environment is 'Sustainable Building' (housing or residential building in this research), which can be analyzed according to the seven aspects of sustainable building (energy, materials, water, indoor environment, surrounding environment, economic and social-cultural).

An analysis of a building based on these aspects will result in a description of the building's sustainable aspects. Nevertheless, questions such as how sustainable it is compared to other buildings and how heavy its impacts are on the environment, etc. are yet to be met. Various tools for this purpose are already available; however, the tool that is chosen for this research is one that can be used by basic social units (a family, or a common neighborhood) of diverse backgrounds and levels of skills, can be applied with the simplest device available and can provide quick assessment. This tool, the DCBA Method, will be discussed in the next section.

2.3 The DCBA Method

Various tools have been developed in order to improve the ecological performance of products and services, based on their life cycles. Among the most widely known companies who developed Life Cycle Assessment (LCA) tools is Pré Consultants[7], who have introduced a number of tools in the form of software and databases (i.e. SimaPro LCA software, Ecoinvent database). Users of these tools require adequate skills, hardware and prior training, therefore their application and results are limited to experts and academics.

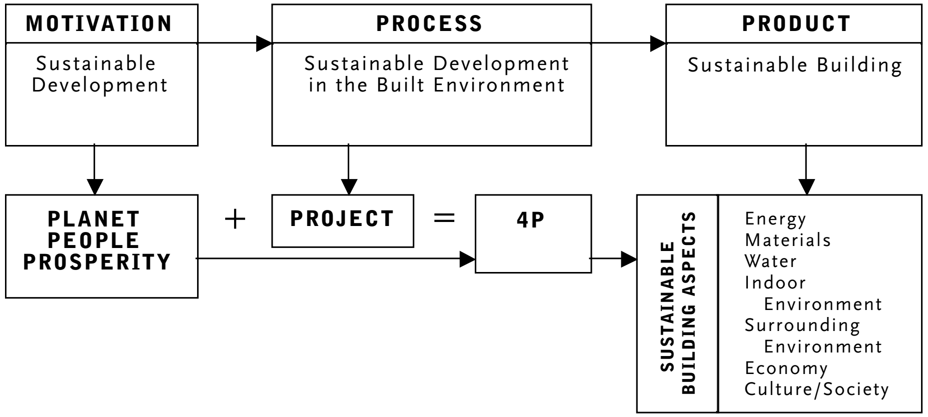


Fig. 2.3: From Sustainable Development to Sustainable Building.

Another tool to compare ecological performance of products and services is DCBA, which was developed by BOOM.[8] A design process needs a decision-making instrument, especially at the beginning of the process, when involving clients – in this case potential inhabitants – and other parties involved (policy makers, investors, developers, etc.). In order to achieve preferred results for all parties, a communicative approach is necessary, especially to rouse discussions, options and ideas for each specific case. The DCBA method has been implemented in various projects and appeared to be an appropriate instrument to fulfill this purpose,[9] therefore it was chosen as the method to compare and measure the sustainability levels of existing examples in this research (see Chapter 4).

The results for each case are presented graphically as 'environmental profiles', so viewers can directly compare the levels of sustainability of these examples under certain variables. Details about the variables that were used for this dissertation will be discussed in the related chapters.

The DCBA method is an environmental assessment tool with which various levels of sustainability can be measured by comparing one situation to another, under defined variables and parameters.
BOOM classifies four ambition levels:

D – The normal situation
C – Correct normal use
B – Minimizing damage to the environment
A – The most favorable or ideal situation

The D variant represents the situation in which no more attention is paid to the environment than required by law. The D level usually represents a conventional way of how a housing process is conducted at present. The C level might also employ a conventional method, but with reduced environmental damage. Activities at the B level should only produce little environmental impact, while the A variant is best for the environment with its near-zero environmental impact.

This method can be used as an instrument of discussion, in order to state the environmental ambition level clearly. This method is also very useful as a gauge, by adding a point system to each level.

Additionally, the method serves as a basis for making environmental profiles. BOOM has used this method for urban planning, housing, renovation, and commercial projects.

The DCBA method is an environmental qualification system that is easily comprehensible and therefore can be an effective communication tool in housing development processes, which makes it possible to actively involve prospective inhabitants during the planning and the building process.

In the next chapter a social-cultural factor is discussed that plays a big part in housing development decisions in Indonesia: the tradition of *gotong royong*, or voluntary communal activity. It is important to look into this tradition before moving on to the existing examples of sustainable housing practice in Indonesia and to the demonstration of the application of DCBA method to these examples.

Notes

1. *The Rio Declaration is accessible at the United Nations website <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>*

2. Agenda 21 *is accessible at the United Nations website <http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm>*

3. *'Chapter 7' of* Agenda 21 *is accessible at the United Nations website http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter7.htm*

4. *The key outcomes of the Johannesburg Summit 2002 are accessible at the United Nations website http://www.un.org/jsummit/html/documents/summit_docs/2009_keyoutcomes_commitments.doc*

5. *The* Green Building Manual *is accessible at the US Department of Energy website http://www.sustainable.doe.gov/pdf/sbt.pdf*

6. *The residential 'green building' guidelines are accessible at B.E.S.T. website http://www.energybuilder.com/greenbld.htm#top*

7. *Pré Consultants (Amersfoort, The Netherlands), whose mission is to develop and implement practical, yet scientifically sound tools to improve the environmental performance of products and services through Life Cycle Management, is accessible at http://www.pre.nl/*

8. *BOOM (a firm of sustainable building consultants in Delft, The Netherlands) is accessible at http://www.boomdelft.nl/*

9. *Among the various projects is the GWL (Gemeentewaterleidingbedrijf) terrain in Amsterdam, a car-free housing area with 600 dwelling units that was completed in 1998.*

Building maintenance as a gotong royong activity (in Malaysia) / Source: www.kmr.upm.edu.my

3 INDONESIAN HOUSING & 'GOTONG ROYONG'

Gotong royong is a phrase referring to mutual self-help activities which can be seen as part of the 'informal economy'. This chapter explains how *gotong royong* has contributed and still contributes to housing development in Indonesian (rural) communities. It starts with a discussion about housing conditions in Indonesia, followed by the background and history of *gotong royong* and its relevance to the current situation in Indonesia. Finally, based on the significant contribution of *gotong royong* to Indonesian society, the chapter ends with the conclusion that social-cultural and economical aspects should be added to Hendriks' sustainable housing themes (2001) when formulating a set of requirements for Indonesian sustainable housing.

3.1 Housing Conditions in Indonesia

This chapter briefly introduces the housing conditions in Indonesia by presenting facts and figures, with the purpose of giving an impression of current housing problems in Indonesia.

HOUSING NEEDS IN INDONESIA

The National Housing Corporation (or *Perumnas* – see separate box: Co-operation and Housing Finance in Indonesia) was established by the Indonesian government with as main task to develop housing in urban areas, especially for middle- and lower-income groups. However, the increasing demand on housing has exceeded the ability of *Perumnas* to fulfill its main task on its own. The private sector, which has vastly developed itself during the last decades, has also been developing housing in urban areas alongside *Perumnas*. The significant growth of the private sector is reflected in the expansion of the Indonesian real estate organization (REI), which had 33 members from Jakarta only in 1972, to more than 2,400 members in 1998 from all 27 provinces in Indonesia. About 75% of REI-members are small- and medium-scale enterprises, which were established in the 80s when 'economic boom' took place. By 1999, a large number of these enterprises were paralyzed due to the economic crisis (Salim; Budihardjo, 1999).

In the fiscal year 1999/2000, the housing sector was allocated 3,8% of the national expenditure. In 2001, 5,983.5 billion IDR[1] was allocated for settlement and development of regional facilities. Yet, the demand for housing still far exceeds the supply. Only 15% of the need for housing is met by public and private sector construction (Ministry of Environment, 2002). These facts show that housing in Indonesia is problematic, especially in urban areas that have the reputation for people from rural areas of being the source of a better income and a comfortable lifestyle. As an illustration, Java island, which has the reputation as the main source of income (within the Indonesian archipelago), has a population density which is much higher compared to the other islands of Indonesia.

In 2000, Java has become the most densely populated area with a 16,333 population density per km².[2] Bali & Nusa Tenggara has a 559 population density per km²,[3] Sumatera 774,[4] Sulawesi 344,[5] Kalimantan 119[6] and Maluku & Papua 6 (see Fig. 3.3). Indonesia, in average, has a 109 population density of per km² in 2000.

The flow of people moving to urban areas is not predictable in number or in direction and provinces of destination. The migration data (see Fig. 3.3) show that in 1980, the province with the highest

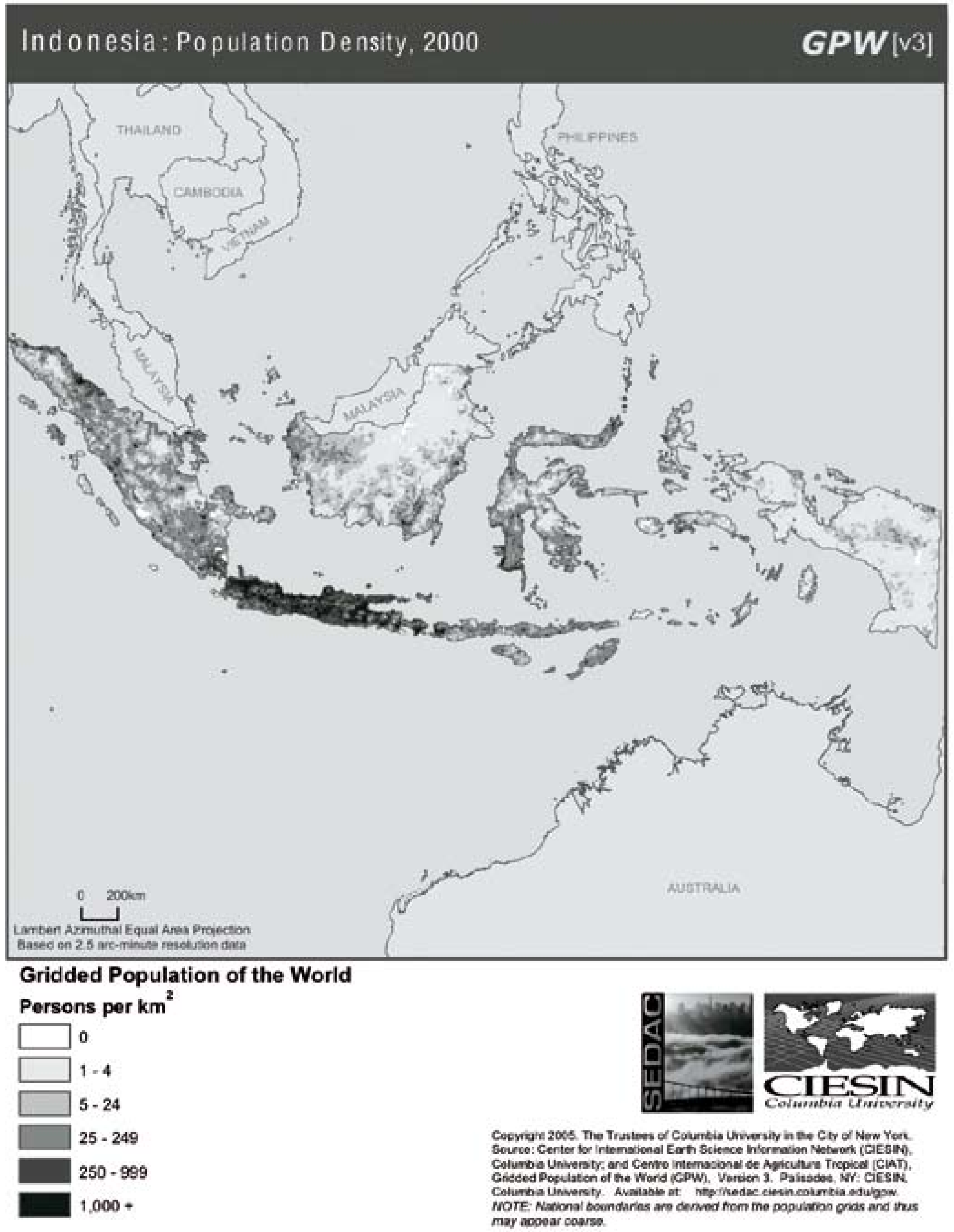


Fig. 3.1: Map of population density in Indonesia / Source: website of SocioEconomic Data and Applications Center/SEDAC, accessible at http://sedac.ciesin.columbia.edu.

in-migration number is DKI Jakarta, followed by Lampung (a province in Sumatera island). In 1990, Central Java reached a drastic in-migration number compared to the previous data, followed by DKI Jakarta and Lampung. In 1995, the province with the highest in-migration number was West Java, followed by DKI Jakarta and Lampung. The unpredictable patterns of migration make it difficult for the regional governments to provide housing for newcomers, or to cope with a sudden lack of inhabitants. The flow of urbanization exceeds the speed of housing development and creates a number of problems, which will be elaborated in the concluding part of this chapter.

In 2000 about 25% of all households in Indonesia lived in houses below the ideal size of 10 m^2 per person as stipulated by the World Health Organization (Ministry of Environment, 2002). In 2003, the highest percentages for urban and rural areas were in the provinces Papua (52,3%), West Nusa Tenggara (46,2%) and East Nusa Tenggara[7] (50,5%). In the most densely populated provinces such as DKI Jakarta and Bali, the percentage reached more than 30% (in urban areas only).

During times of economic crisis, less people can afford to buy a house and in fact a substantial part of the community cannot afford to pay housing credit; others have even been forced to sell their houses in order to obtain cash money. The lack of affordable housing has partly led to the development of slum settlements, which in Indonesia amounted to 4 million ha in 1996.

These facts show that Indonesian regional governments face difficulties in predicting the increasing or decreasing population numbers and providing an adequate amount of housing facilities, especially in dense urban areas. This condition is worsened by the reluctance of the regional governments to recognize indigenous *kampung*s, which have been inhabited for many generations, as a formal administrative part of the city. *Kampung*s inhabitants are commonly people whose income sources is in the informal sector: they possess no certifications for land ownership. It is difficult for these people to obtain such certificates since they lack of proper identification, formal documents and financial capital, which has forced them to build illegitimate settlements.

This situation has naturally led to poor living quality (i.e. sub-standard sanitary facilities, water supply, social interaction), as well as damage to the surrounding environment (i.e. deficient garbage disposal, infrastructure, urban planning). In order to cope with the lack of (affordable) housing, the government has provided low-cost housing for these squatters. However, the resulting public housing facilities do not fully fit their purposes, due to economical matters (financial resources and management), resource availability (land), inferior building quality,[8] frailty of legal performance,[9] and social/cultural influences.[10] These housing problems are actually not only common in Indonesia, but also in developing countries with similar conditions (dense population, middle- and low-income majority and lack of governmental control).

In the case of DKI Jakarta, Harjoko (2004) mentions that 'kampungs *have never been formally incorporated into city's development plan. The city planners often see* kampung *as a 'blank' space in the urban system, subject to potential sources for private investments and regional government revenues'*. According to Jakarta Social Welfare Provincial Office, in 2005 there are no less than 30 illegal or poor *kampung*s in Jakarta, which are commonly located on river banks or railway sides. Komarudin (1997, p. 96) mentions that these illegal *kampung*s are mainly characterized by their land status (which are usually a property of the state, an institution, a legal body, a foundation or individuals other than the inhabitants), occupation without any permission from the land owners and irregular and unsafe buildings. Their existence, both settlements and income grounds, is restricted through the regional law (i.e. Perda DKI Jakarta No. 11/1989, concerning regulations of public space usage), which legitimates eviction or demolishment of their quarters.

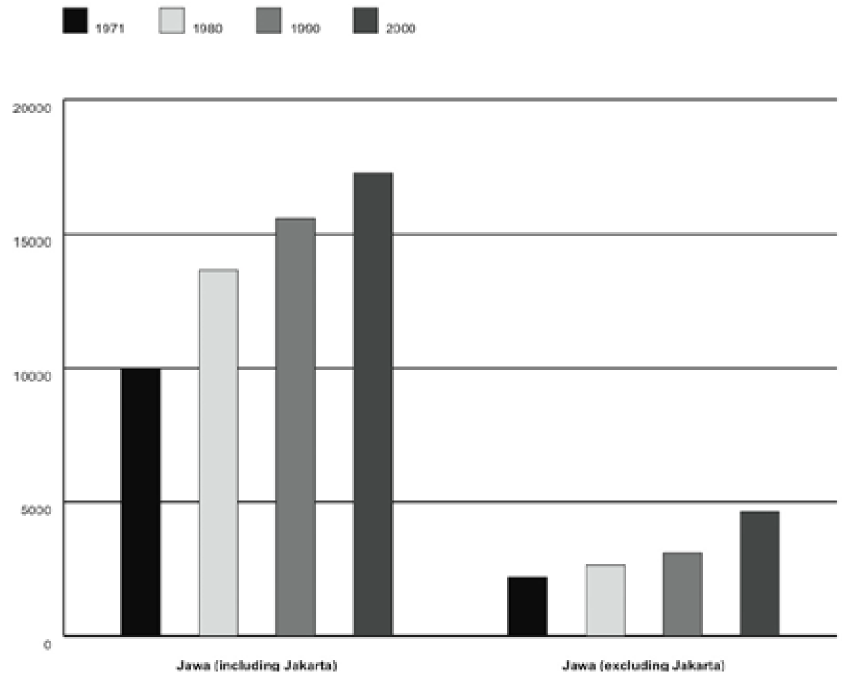


Fig. 3.2: Population Density per km² for Java, including Jakarta and Java, excluding Jakarta.
Source: 1971, 1980, 1990, 200 Population Census and 1995 Intercensal Population Census

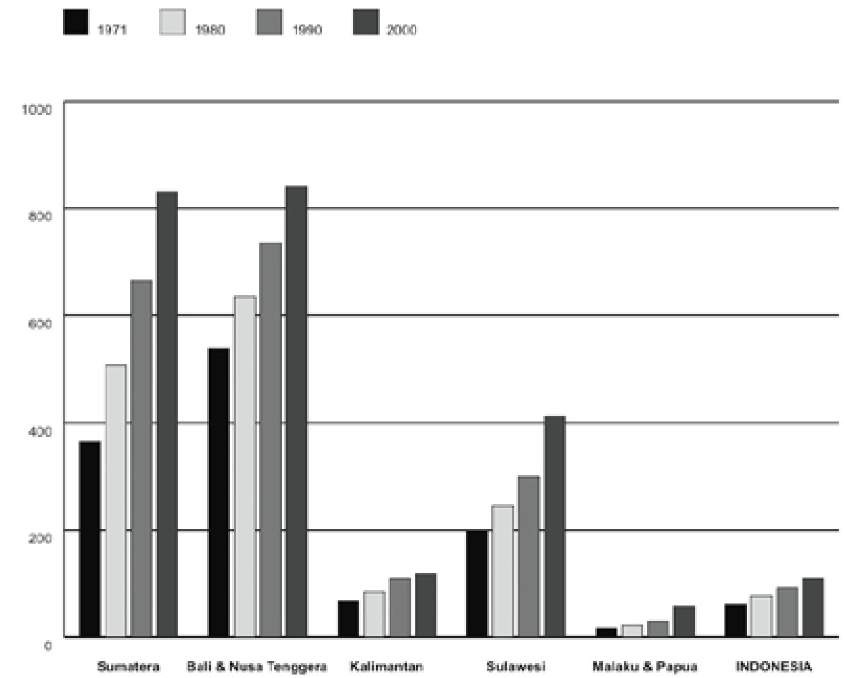


Fig. 3.3 Population Density per km² for Sumatera, Bali & Nusa Tenggara, Kalimantan, Sulawesi, Maluku & Papua and Indonesia.
Source: 1971, 1980, 1990, 200 Population Census and 1995 Intercensal Population Census

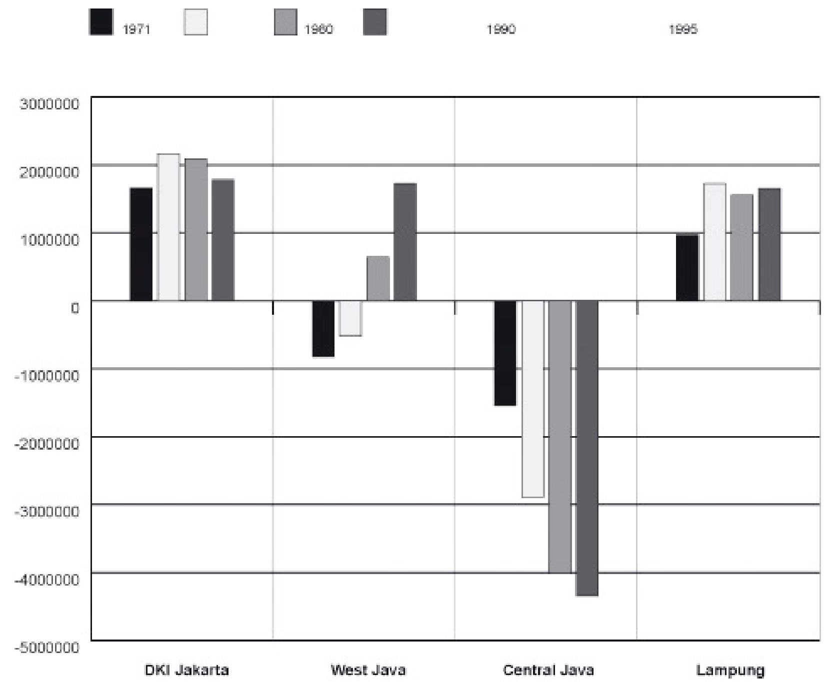


Fig. 3.4: Life Time Migration, 1971-1995

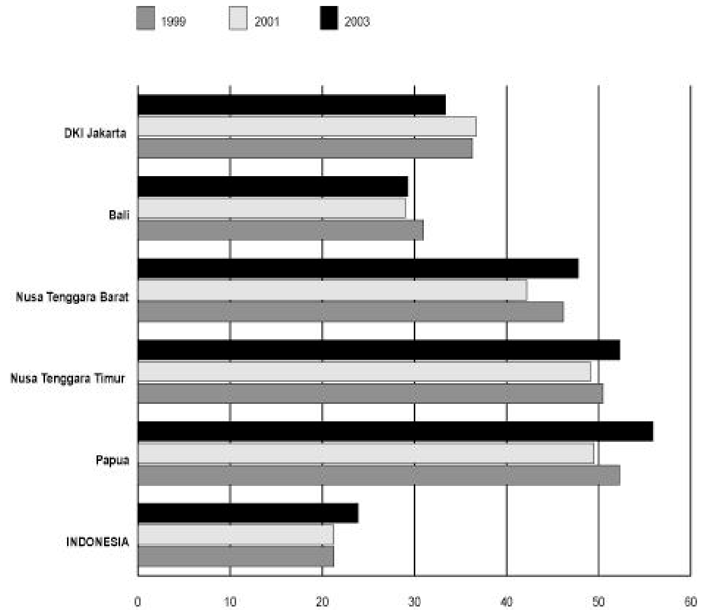


Fig. 3.5: Percentage of households with floor area less than 9 m²/person, 1999-2003

Efforts have been made to cope with this ongoing problem. The Indonesian government has conducted urban renewal programs such as the *Kampung* Improvement Program/KIP (an example from KIP is elaborated in Chapter 4.2), beside providing special loans for the low-income groups. However, these efforts have not yet reached satisfactory results. The urban renewal programs in reality have faced complicated challenges during the negotiation process (i.e. disagreements between the squatters and the government and developers about compensation of land prices, temporary settlements and land ownership). These disagreements commonly leads to forced evictions of *kampung*s. Another problem is lack of discipline concerning the special loans and facilities that are provided for the low-income groups: people who are not entitled to the facilities can always manage to acquire them (see Chapter 5.1, *Further Investigation* section, for an elaboration about frail legal performance in the housing field).

Another effort which can be considered a success is the Code River case in Yogyakarta. Settlements on the banks of the Code River were planned to be demolished by the local government, causing a sympathetic initiator (a former priest, architect and writer) to campaign against the demolition (this case is elaborated in Chapter 6.2). The initiator and the Code River community, along with their supporters, worked together to create an acceptable settlement, and succeeded. The government issued land occupation certifications for the Code River community, whose site has received international acclaim and has become one of the city's tourist attractions.

This working method is actually in accordance with Wood (1972), who suggested that, beside investments in social and educational services, involvement of community members to participate in a self-help improvement program will assure the good use and maintenance of the physical facilities. This corresponds to one of the cultural resources with the highest potential to accomplish a sustainable domestic environment: *gotong royong*, a traditional culture of communal activities in Indonesia, which is discussed at length in the next section.

3.2 Introduction to 'Gotong Royong'

Gotong royong is a phrase applied to voluntary communal activities among Indonesian people, which is part of the so-called 'informal economy'. It is not easy to precisely define *informal economy*, due to the dynamic character and continuous development of informal economy activities. One commonly used working definition is: all currently unregistered economic activities, which contribute to the officially calculated (or observed) Gross National Product.[11] Another definition is: market-based production of goods and services, whether legal or illegal that escapes detection in the official estimates of Gross Domestic Product. As these definitions still leave open a lot of questions, table 3.1 may be helpful for developing a better feeling for what could be a reasonable consensus definition of the legal and illegal underground or informal economy. Referring to the table, *gotong royong* activities mainly fall into the category of Non Monetary Transaction of Legal Activities.

The informal economy comprises of those economic activities which are excluded from the benefits and rights incorporated in the laws and administrative rules covering property relationships, commercial licensing, labour contracts, torts, financial credit and social security systems (Feige, 1990). The informal economy consists of barter, mutual self-help, odd jobs, allotment farming, street trading, and other similar activities. Most of the world's population participate in local informal economies: among 111 countries, Indonesia rates as the 81st country of the highest informal economy rate with 19,4% of the population in the informal economy sector (Schneider, 2002 and NationMaster, 2003-2006).[12]

Table 3.1: A Taxonomy of Types of Underground Economic Activities (modified by Schneider, 2002, from Lippert and Walker, 1997)

TYPE OF ACTIVITY	MONETARY TRANSACTION		NON MONATERY TRANSACTION	
Illegal Activities	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling and fraud		Barter of drugs, stolen goods, smuggling, etc. Produce or growing drugs for own use. Theft for own use.	
Legal Activities*	Tax Evasion	Tax Avoidance	Tax Evasion	Tax Avoidance
	Unreported income from self-employment; wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and good	All do-it-yourself work and neighbor help

** Since all income should be reported to the tax office. However, it is not easy to classify each of these activities, or to see it black-and-white as legal or illegal, due to various circumstances that may occur. Therefore, considering the complexity of the matter and the proportion of the thesis' contents, this subject will not be discussed in length.*

3.2.1 History of 'Gotong Royong'

Gotong royong has emerged among 'pre-Indonesian' peoples who succeeded in arranging their life through a certain social organization. They were used to living according to traditional rules (*adat*). The rules were not written, but it was believed that material and spiritual sanctions would come automatically to those who disobeyed them. This social organization emphasizes communal efforts, and these activities acquired the present name of *gotong royong* (Wargadipoera, 1954).

According to Koentjaraningrat (1961), the meaning given to the term *gotong royong* by the general public is 'co-operation among members of a community'. The use of the term *gotong royong* was originally confined to the village sphere. Koentjaraningrat categorizes *gotong royong* into seven types:

1. *gotong royong* activities which emerge when there is a case of death or some other calamity in the family of village inhabitants
2. *gotong royong* activities undertaken by the whole village when there is a project which all feel is a public necessity
3. *gotong royong* activities which occur when a villager institutes a feast
4. the *gotong royong* system applied to the care and cleaning of ancestral graves
5. *gotong royong* activities which take place when an inhabitant of the village needs work to be done around his house

Fig. 3.6: A gotong royong *activity to build a house in a Sumbanese village (Dawson & Gillow, 1994). Like other traditional Sumbanese houses, the roof of this house is high, shaped as a truncated pyramid rising from five to seven levels, and topped with a projecting wooden beam at both ends. The wooden beams on the roof are believed to be the entrance for the ancestor spirits (*marapu*) to enter the house and give blessings to their descendants. The presence of* marapu *is omnipresent among the living and the house is also seen as an important place of ancestor worship (Indonesia Archeology on the Net: http://www.arkeologi.net). The high ceiling allows natural ventilation, and the thatched grass that covers the roof structure protects the dwellers from heat and rain.*

6 the system and activities of *gotong royong* manifested at the time of (heightened) agricultural production in all its aspects
7 *gotong royong* activities based on the duty of the worker class to contribute manpower for the benefit of the community

Gotong royong types (2) and (5), where a communal project is commenced for housing/domestic purposes, are the most relevant to the subject of sustainable housing, which is the main topic of this dissertation.

Koentjaraningrat (1961) found that *gotong royong* is one of the most abused terms in the Indonesian language, because during the 1950s the term had acquired increasing currency among Indonesian political leaders and economic planners concerned with national problems. Therefore we should be aware that originally the practice of *gotong royong* is conducted purely by local communities with their own efforts, and the results should be for the benefit of those local communities themselves.

3.2.2 The Contribution of 'Gotong Royong' to Sustainable Housing

In order to conduct *gotong royong* activities on a neighbourhood scale, it is necessary to have the following elements:

- *Initiators*: people who hold an important social position and who can motivate the community to co-operate in projects. Their position is not necessarily that of a leader, but they should be able to organize and encourage the co-operating community. If these initiators are people who come from, or are already known by the co-operating community, the approach to the community might come naturally. If people from outside of the community (skilled experts, scientists, etc.) would like to act as initiators in a *gotong royong* practice, they should (Larasati, 2003):
  (1) understand the specific local conditions, terms and needs to be able to adjust the level of technology that will be applied;
  (2) be realistic in setting the goals and future plans of the projects;
  (3) respect and take advantage of the potentialities of the local community;
  (4) be able to motivate and convince the majority of the people to be actively involved in the projects.
- A *group of people* who have a common interest towards their living environment, bonded by their domicile. It is common for people who are involved in a *gotong royong* project to have some kind of bond. These people would work voluntarily, according to their will and ability. They are usually people with a sense of belonging to their community, who feel responsible and enjoy their contribution to their surrounding environment. This social aspect, which is said to be an original and strong Indonesian spirit of kinship (Wargadipoera, 1954), is essential in the practice of *gotong royong*.
- *Activity programs* should be able to accommodate the various skills and interests of the individuals in the co-operating community.
- *Goals*: *gotong royong* programs should aim for results that benefit the community. A number of extra advantages sometimes occur, such as positive environmental and social impacts on neighbouring communities. Moreover, the community can gain a favourable reputation by receiving (inter)national recognition.

In one of the existing examples of Indonesian sustainable housing practice, these elements are evidently present and turned out to be the success factor of the *gotong royong* process.[13] This form of communal participation is most controllable at neighborhood or village level. The goals can be achieved successfully when at least up to 80% of the inhabitants take part actively in the program.[14]

3.3 Failure and Success Factors of 'Gotong Royong' in Housing Activities

Indigenously emerged from rural communities, the spirit of *gotong royong* is believed to be fading because of current changes in lifestyle. However, this is not the case in some urban communities. Next follows a discussion about the feasibilities, obstacles and opportunities of the implementation of *gotong royong* in contemporary, urban Indonesian society.

Wargadipoera (1954) has described challenges (failure factors) that might disintegrate the *gotong royong* activities, some of which are still relevant at present:

1. Corruption in *gotong royong* activities. *Gotong royong* is a voluntary activity, where materials are provided, without charge, by its participants. When corruption occurs, i.e. using the materials for personal use, the activity is disrupted.
2. The use of *gotong royong* projects for personal (political) purposes. A communal project should be conducted by and for the benefit of the community itself, not for the credit of an individual or a certain party.
3. The use of 'money economics' and area expansion. If there is money involved in a *gotong royong* activity, it should be circulated without priority on making profit.
4. Lack of maintenance in the development of a *gotong royong* organization structure. The organization of a *gotong royong* project needs to be up-to-date with the current situation, i.e. improving the human resource management.
5. Lack of economic skills & understanding.
6. Degradation of the kinship principle. The current non-traditional lifestyle, which is more individual and lacking a sense of belonging to communal facilities, reduces the motivation and involvement of the local community
7. Pressure from population density. A group of people can work effectively and comfortably within a limited number of people.
8. Income/wealth gap. If the economic gap between members of the community is too wide, it will be difficult for them to mingle and do things together.

Meanwhile, there are also success factors that help achieving the goals of a *gotong royong* activity (Larasati, 2004):

1. *Relationship*: The inter-personal relationship between the community members. In a gotong royong project, it is helpful to get acquainted in person with the involved individuals, to be able to cope with (personal) problems that might occur during the project.
2. *Capital*: The (relatively small) capital that is needed to be able to conduct the activities. In self-initiated communal activities, it is essential to start with realistic capital and goals, in order to minimize financial risks.
3. *Technology* (the variation of technology that is used to run a project): It helps to apply a technology that can be managed and maintained by the community itself, in order to minimize technical problems that might occur.
4. *Professional Input*: In the expanding process of *gotong royong*, contributions from professionals, trained personnel, or skilled experts from outside the community are, on occasions, necessary. The assistance from this external party might provide material support and sponsorships as well.

3.4 Conclusions

Gotong royong activities can contribute to a sustainable living environment in several ways:

ECONOMICALLY

- The inhabitants participate by providing energy and materials in the building and maintenance process. Therefore few or no extra expenses are needed for professional building labour.
- Another possible contribution can occur in the form of financial sponsorships and technology upgrades, as long as there is a guarantee that the village inhabitants themselves are able to manage and maintain any form of external assistance.

SOCIALLY

- The inhabitants build a sense of belonging and pride towards all the facilities that materialized because of their own efforts; thus increasing their self-esteem and their feeling of kinship within the community.
- Activities are self-motivated and based on own-efforts, concerning financial and human resources.
- By being able to conduct the communal activities independently and continuously, the community is developing itself towards a form of sustainable community.
- Contributions from external resources are possible in the form of support from professionals, trained personnel, or skilled experts to update the knowledge applied in the village.
- Initiators are the most important element in a *gotong royong* project, since they are the ones who stimulate and motivate the community, and ensure the continuity of the project.

ENVIRONMENTALLY

- When the inhabitants use local resources to build or maintain their surrounding environment, the energy that otherwise would have been spent on fuel, materials, etc., which have to be transported from outside the community, can be saved.
- Environmental activities can improve the living environment in a common village. Therefore these activities can be part of a practice towards the creation of sustainable housing.

Attempts to create an Indonesian sustainable housing practice should consider the specific characteristics and potentialities of the local area. Therefore it is important to preserve the original nature of *gotong royong* among the Indonesian people, since it is a potential capital appropriate to the Indonesian condition, with its abundance of human resources.

Economic and social-cultural aspects are proven to be indispensable factors in Indonesian housing projects, with the *gotong royong* tradition as a way to cope with limited financial capital. Therefore these aspects are added to the sustainable building themes from Hendriks (2001).

CO-OPERATION AND HOUSING FINANCE IN INDONESIA[15]

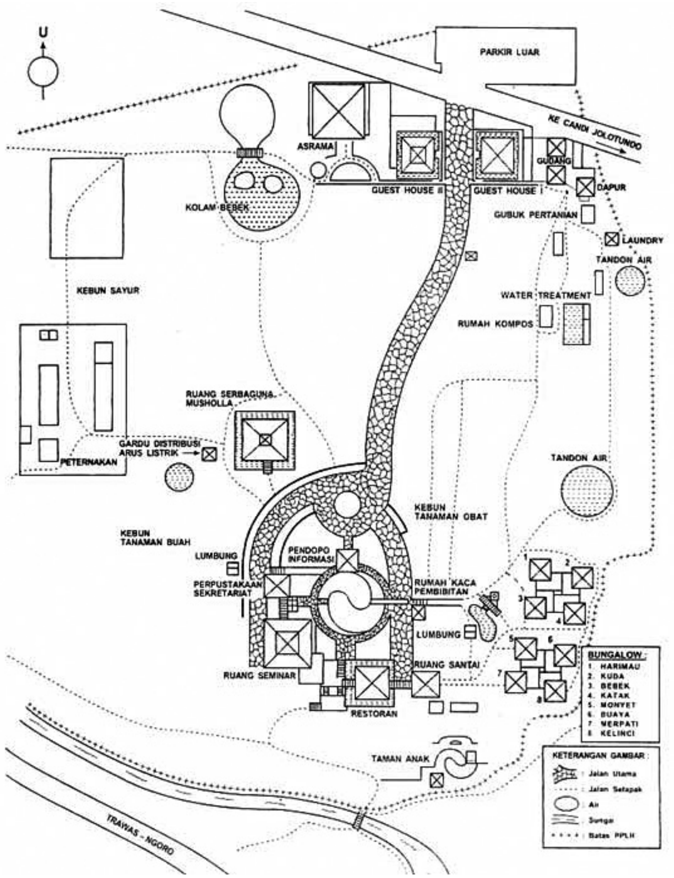
- NV Volks Huisvesting, which was established in the 19th century by the colonial (Dutch-Indies) government, had as main task to build housing in big cities in a limited amount. Its other task was to build public housing and conduct village improvement.
- In 1896, the first cooperatives ideas were introduced through the establishment of a bank for government official staffs in Central Java; followed in 1908 by the founding of Budi Utomo, *an institution that played an important role in the cooperative movement. In 1927 the Islamic Trader Union was established to gain bargaining power among indigenous entrepreneurs.*
- In 1930 the Dutch-Indies government constituted a Cooperatives Bureau under the Ministry of Domestic Affairs, which' task was registering and legalizing cooperation organizations. The location and name of this bureau, which' duties later also covered commerce for indigenous entrepreneurs, have changed among different departments until the Japanese occupation era (1942-1945), when the Cooperative Bureau became a part of the People Economic Office.
- Since 1945 the Cooperative Bureau has been established under various ministries until it became independent as Cooperative Department (and later, in 1966, as Trading and Cooperatives Ministry).
- The Housing Department was established in 1952, following the forming of a Public Housing Development Treasury Foundation which nature was semi-cooperative (only its members were allowed loans).
*- In 1972 the first urban study was conducted, sponsored by The World Bank, which strongly recommended the Indonesian government to form an institution that would be responsible for housing policies, which resulted in the establishment of the National Housing Policy Institution (BKPN) in 1974, along with The Public Corporation of National Housing (*Perum Perumnas*) and The State Savings Bank (BTN). From 1974-1982, the first decade of* Perumnas' *work, mass-produced in thousands of housing. In the second period (1982-1991), the state's capital was stopped and the method was oriented to market economy system, which became effective in 1998. The third period (1992-2003) was filled with* Perumnas' *efforts to sustain itself, based on its own financial capital.*
- In mid-1997, at the beginning of economic crisis in Indonesia, the buying power of the lower-income groups decreased sharply. The housing market became more competitive, due to the more critical customers. Starting 2003, Perumnas *cooperated with various institutions (i.e. the army/police force, regional government, private sectors), which resulted in more than 35.000 housing units for both civil servants and non-civil servants. The Trading and Cooperatives Ministry has been variously renamed until 1999, when it was declared as the State Ministry of Cooperatives and Small Medium Enterprises.*

*The National Housing Cooperation (*Koperasi Pemukiman Nasional/KOPENAS*) is one of the secondary cooperative organizations at the national level. At present, there are five roles for a housing cooperation:*

1. *As a developer or an executor of a housing project, which serves its members and non-members.*
2. *As a coordinator for its members who want to buy a house from a developer. It does not have a legal body and is obliged to make an inventory of its members who are qualified as the State Savings Bank/BTN debtors, to coordinate the application of Public Housing Credit/KPR and Land Ownership Credit/KPKSB on behalf of the relevant members.*
3. *As a BTN debtor, of which houses are to be rented or sold to its members.*
4. *As a guarantor for its members who buy their house with KPR-BTN facilities. It should have a legal status.*
5. *As two or more roles mentioned above.*

Notes

1. *This amount equals about 895 million US dollar (1 US dollar = 9,500 IDR as of 2 March 2003)*
2. *The statistics of Java island consist of accumulated data from the provinces of Jakarta, West Java, Central Java, Yogyakarta and East Java.*
3. *The statistics of Nusa Tenggara consist of accumulated data from the provinces of Bali, West Nusa Tenggara and East Nusa Tenggara.*
4. *The statistics of Sumatra Island consist of accumulated data from the provinces of Nanggroe Aceh Darussalam, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung and Bangka Belitung Islands.*
5. *The statistics of Sulawesi Island consist of accumulated data from the provinces of North Sulawesi, Central Sulawesi, South Sulawesi, South-East Sulawesi and Gorontalo.*
6. *The statistics of Kalimantan Island consist of accumulated data from the provinces of West Kalimantan, Central Kalimantan, South Kalimantan and East Kalimantan.*
7. *West Nusa Tenggara and East Nusa Tenggara (Kupang is the capital of East Nusa Tenggara) are islands located east of Bali island (see Fig. 3.4).*
8. *Low cost housing is often not favorable to live in, due to their improper building design that uses inappropriate materials and that does not consider indoor thermal comfort as priority (Mufida, 1998).*
9. *Low-cost housing located in the center of urban areas is aimed at low-income people, so they can afford their shelter and do not have to make extra expenses for transportation. However, this type of housing is often bought by middle- or high-income people who already have their own houses, as an investment (to rent out with higher price, etc.). There is no strict law enforcement to cope with this situation yet.*
10. *To mention one: Indonesian people are not in favor of owning an (apartment) floor, since it is different from owning land, on which a house can be extended in order to accommodate more (extended) family members.*
11. *According to Schneider (2002), this definition is used by Feige (1989, 1994), Schneider (1994a), Frey and Pommerehne (1984), and Lubell (1991).*
12. *The Netherlands, with 13% of the population in the informal economy sector, ranks at 98th from 111. The country with the highest population percentage in the informal economy sector is Georgia (67,3%). Weighed Average from the 111 countries is 33% (source: NationMaster site, accessible at: http://www.nationmaster.com/red/graph-T/eco_inf_eco)*
13. *See Chapter 4 about Banjarsari Village, where initiators have a great influence in achieving successful results.*
14. *This is evident in the case of the* Kampung *Improvement Project (see Chapter 4), where, if less than 80% of the inhabitants were actively involved, some programs might not perform as planned.*
15. *See also Appendix B: A timeline figure of Co-operation and Housing Finance in The Netherlands and Indonesia. Source: 'Dutch Social Housing in a Nutshell' by Aedes vereniging van woningcorporaties, 2003 and the Indonesian Ministry of Cooperative, Small and Medium Enterprises.*



Ground plan of the resort of Environmental Education Center (Pusat Penelitian Lingkungan Hidup) *in Seloliman, East Java (see page 56-58) / Source: http://www.pplh.or.id*

4 ANALYSIS OF EXISTING EXAMPLES

This chapter analyzes existing examples of housing programs and similar efforts made by the Indonesian government and other (private and scientific) institutions to improve the domestic environment, which can be categorized as sustainable housing practices. The following cases are used to draw overall conclusions at the end of the chapter:

1. The Healthy Housing Campaign of the government
2. The *Kampung* Improvement Program (KIP) of the government
3. The Eco-house built by Sepuluh Nopember Institute of Technology (ITS), Surabaya, for research aimed at passive-cooling technology application
4. A mountain resort built by Environmental Education Center/*Pusat Penelitian Lingkungan Hidup* (PPLH) in Seloliman, East-Java.
5. The self-supportive environmental improvement of Banjarsari Village in Cilandak, Jakarta

4.1 Healthy House Campaign

The National Urban Development Corporation (*Perum Perumnas*), which' main task (since more than 30 years) has been to conduct (low-cost) housing and infrastructure development in all urban areas throughout Indonesia (including re-building in conflict regions such as Aceh and Ambon),[1] refers to a 'healthy house' as a modest house that consists of three types, based on the width: core house (18-27 m^2), very modest house (21-36 m^2) and modest house (36-70 m^2). In principle, every housing built by *Perum Perumnas* should include adequate facilities:

- road and water sewer/drainage
- access to electricity, water, telephone and public street lighting
- commercial areas, i.e. offices, shops, marketplaces
- semi-commercial areas for health clinic, post office, education center, etc.
- social facilities, i.e. a park or an open space, a building for religious services, a sports center, etc.

However, low-cost housing development could not be carried out as planned: the target to build 480.000 units of very modest housing and 120.000 units of modest housing in 1999 was hard to achieve, due to difficulties in maintaining low prices for the housing during the development period. In order to cope with this problem, it is necessary to apply a comprehensive and integrated policy, along with partnership among the government, private sectors and local communities (Komarudin, 1997).

The term 'healthy housing' was issued by the government in order to persuade the majority of the Indonesian people, who are not familiar with the term 'sustainable' or 'ecological housing', to create and maintain a healthy living environment.[2] The National Healthy Housing Campaign was first announced by President Soeharto at the opening of the National Housing Conference on 16 November 1992. A general healthy housing guideline (see Fig. 4.2) and general and specific technical guidelines are available for the public,[3] which is expected to understand and accept these concepts, and actively participate in their domestic environment, for the benefit of their own and their family members' health. Therefore the common terms that are used in the context of housing projects and housing development in Indonesia are 'health' and 'cleanness', instead of 'sustainability'.

Fig. 4.1: Map of Java Island, with pointers at locations of the sustainable housing examples treated in this chapter.

The Department of Public Works (1999) states that a 'healthy house' should possess:

1 Housing components: roof, walls, windows, doors, floor and foundation
2 Housing facilities: access to clean water, sewers, toilet, garbage disposal, lighting
3 Housing plans: space planning and housing construction
4 Building regulations, neighborhood relationships and housing maintenance

Corresponding to the seven aspects of sustainability, based on the government's recommendations, Healthy Housing can be described as follows:

ENERGY

- Every housing area should be supplied with access to electricity and water, along with sewers and all supporting facilities, subsidized by the government, private building sectors and other sponsors. It is recommended to use natural lighting as much as possible, among others by positioning the house so that sunlight is allowed into the building. A working space should be in an East-West position and bedrooms North-South.

MATERIALS

- Materials (especially for modest housing) are limited to the most inexpensive choices, therefore locally produced materials are preferable.
  Functions and specific materials and measurements of each housing component:
- The roof functions as a protection from heat, dust and rain. Roof coverings consist of flat and angled parts, depending on the material.
- The ceiling functions as heat absorbent. The height of the ceiling should be at least 240 cm. Ceiling materials can be bamboo or wood planks.
- The walls function as a protection against wind and dust, and are not made transparent. Walls can be made of woven bamboo, wood planks or bricks.
- The floor should be in a dry condition/not damp. Floor coverings can be made of tiles, stone, terrazzo or bricks. The floor height of non-elevated houses should be at least 10 cm above the yard and 25 cm above the road. For elevated houses, floor coverings can be made of woven bamboo or wood planks.

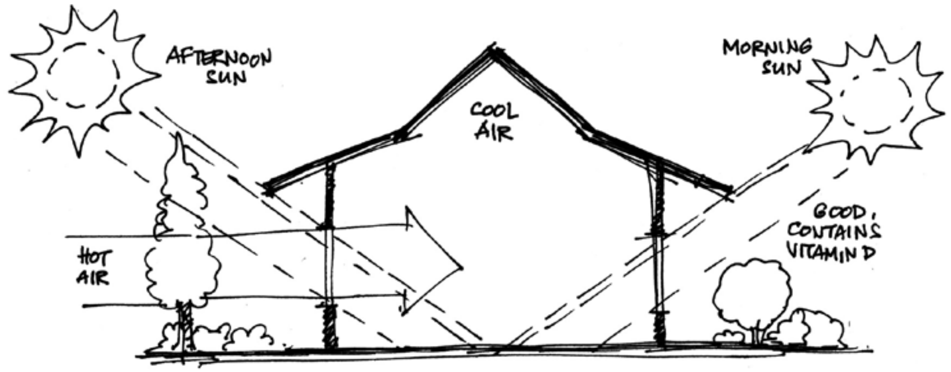


Fig.4.2: An illustration from the general healthy housing guideline, showing the 'morning sun' (at the right – explained as 'good, contains Vitamin D') and the 'afternoon sun' (at the left – bringing 'hot air'). The text under the ceiling is 'cool air'. Source: website of the Department of Public Works

Fig. 4.3: Rumah Sederhana Sehat *(RsS) or modest healthy housing built by Real Estat Indonesia/REI, the Indonesian association of private developers. (Photo source: Liputan 6)*

- The foundation functions as a stabilizer of the house, as a construction that connects the house with the ground and to direct the houses' weight into the ground. The foundation can be made of river stones, bricks and concrete.

WATER

- Each house should have a shallow water well and a sewer. Waste water from bathroom, laundry and kitchen activities should be directed to an open or closed sewer in the yard, into a sewer at the side of the road.

INDOOR ENVIRONMENT

- 'Modest houses' are built according to the Indonesian National Standard (SNI) building specifications, which means that the minimum floor area covers 12 m^2, and the maximum 36m^2.
- Ventilation should guarantee airflow and flooring should be kept dry and clean, while the walls and roofs should be able to protect the inhabitants from solar heat.

Table 4.1: Analysis of the Healthy Housing Campaign according to the seven aspects of sustainability

ASPECTS OF SUSTAINABILITY	ANALYSIS OF THE HEALTHY HOUSING CAMPAIGN
ENERGY	Basic access to electricity grid. Recommendation to use natural lighting (by allowing sunlight to enter the house and by the positioning of the house), which reduces energy use for artificial lighting.
MATERIALS	Limited to the most inexpensive choices, therefore locally produced materials are most suitable.
WATER	Basic access to the state's water supply. Assignment for each house to provide one (shallow) well as the main water resource and a sewer for waste water; also sewers in the yard and at the road sides.
INDOOR ENVIRONMENT	Refer to the Indonesian National Standard (SNI) for building specifications. Assignment for each house to provide: separate rooms according to each function, minimum space width (at least 9 m^2/person), minimum ventilation surface width (1 m^2/person), adequate ventilation (that guarantees airflow) and regular maintenance of components (roof, floors, ceilings, walls, etc.).
SURROUNDING ENVIRONMENT	Assigning each house to provide a garbage disposal site (such as a hole in the ground, a drum or a garbage container) and to maintain the surrounding environment.
ECONOMIC	Healthy Housing guidelines do not specifically mention the financial arrangement; therefore it is assumed that a conventional housing mortgage or subsidies for the low income groups is applied.
SOCIAL-CULTURAL	Encouragement to create a harmonious relationship among neighbours.

- Airflow and sunlight should be allowed into the house through windows. Ventilation surfaces are best located in the direction of wind flows.
- Housing maintenance: fix every roof leakage immediately, since it influences the durability of the building materials; floors should always be clean, dry and free of dust; ceilings should be cleaned regularly; walls should always be clean, painting walls regularly can prevent wear-out; bathrooms, bath water containers and toilets should be cleaned regularly.
- Space planning: each person should be provided a space of at least 9 m^2. The width of the ventilation surface should be minimally 1/9th of the whole floor width, or 1 m^2 for each person.
- Each house should provide a separate living room, dining room, bedrooms, kitchen and bath/laundry room.

SURROUNDING ENVIRONMENT

- Roads should be provided for pedestrians and vehicles (also allowing access of emergency services such as fire engines).
- Low-cost housing should be built in areas that are free of flooding or have low flooding risk (however, several cases have shown that a number of low-cost housing areas have suffered from flooding).
- A garbage disposal should be provided in the form of a hole in the ground, a drum or a garbage container. A garbage container should be closed to keep out flies or other animals.
- Maintenance of the surrounding environment: yards should be cleaned from dirt, garbage and water puddles. Water sewage should not contaminate water wells and other water resources.

Fig. 4.4a: A street of an improved kampung, which width is adequate for small vehicles (Photo courtesy of Professor Jeff Kenworthy, Murdoch University, Western Australia) / Fig. 4.4b: A street of an improved kampung, which also functions as a place to socialize (Photo courtesy of Professor Jeff Kenworthy, Murdoch University, Western Australia)

ECONOMIC

- 'Modest houses' are aimed at residents of the lowest-income group of society.[4] 'Very modest houses' are located at the heart of an urban area, with the purpose of reducing travel/transportation costs of their inhabitants whose income mainly comes from the city center.

SOCIAL-CULTURAL

- Harmonious living among neighbours is encouraged, as well as active participation in communal projects. The importance of active participation in the local community is mentioned in the guidelines of low-cost housing development.

4.2 *Kampung* Improvement Program (KIP)

The *Kampung* Improvement Program/KIP is a government-initiated program that started in 1970 with support from the World Bank, and has gained overall positive results, although a number of aspects need revising. KIP was conducted in growing urban areas, among others Jakarta, Surabaya, Bandung and Denpasar. KIP aimed to upgrade domestic living quality in slum settlements in dense urban areas.

A slum settlement is defined (Komarudin, 1997) as a settlement:

- that is occupied by more than 500 people per hectare
- that has low economic and social conditions
- that consists of dwellings with sizes below standard
- where housing facilities and infrastructure are hardly available or are not built according to proper health and technical standards
- that is built on state property or on other people's private properties
- that is not built according to housing regulations

A report from the Operations Evaluation Department of the World Bank (1996) looked into the impact of the projects that were part of KIP. Corresponding to the seven aspects of sustainability, the analysis of KIP is as follows:

Table 4.2: Analysis of KIP according to the seven aspects of sustainability

ASPECTS OF SUSTAINABILITY	ANALYSIS OF KIP
ENERGY	Improvement in electricity access. Conventional energy source (using PLN, the state's electricity grid)
MATERIALS	Houses are upgraded by 'permanent' or high-quality materials (brick/cement walls, tile/terazzo and cement floors, and tile and zinc roofs).
WATER	Wider access to clean and safe water and better drainage (hence less frequent flooding).
INDOOR ENVIRONMENT	Residents are familiar with 'Healthy House' standards.
SURROUNDING ENVIRONMENT	Improved facilities: housing, footpaths, lighting and education and health facilities.
ECONOMIC	KIP improved the quality of domestic living in Indonesian urban areas at a low cost of investment.
SOCIAL-CULTURAL	Inadequate operation and maintenance: garbage problems (dumped into sewage and drainage). An important outcome was the spillover effect: the KIP experience served as a prototype for investment and improvement in other areas.

ENERGY

- The aspect of energy was not specifically mentioned in the World Bank report. However, since the infrastructure development included lighting, it can be assumed that KIP areas received improvement in electricity access.

MATERIALS

- KIP areas had their houses upgraded by the application of 'permanent' or high-quality materials. Most residents have brick/cement walls, tile/terazzo and cement floors, and tile and zinc roofs.

WATER

- Wider access to clean and safe water and better drainage (hence less frequent flooding) are included in the program. However, access to safe drinking water is still not universal. Non-KIP slum residents tend to rely more on street vendors for water, but both KIP and non-KIP slums frequently use water from wells. However, well water is often polluted by saline and other contaminants, and use of wells contributes to land subsidence, flooding, saline intrusion and damage to fisheries.

INDOOR ENVIRONMENT

- KIP areas are more spacious and less dense than non-KIP areas; KIP residents are better educated and healthier, and household sizes have declined. 61 percent of KIP residents say they have no flooding in or outside their homes (compared to only 32 percent of non-KIP residents). It can be assumed that KIP residents already had knowledge about 'healthy house' standards (See Chapter 4.1).

SURROUNDING ENVIRONMENT

- Improved facilities: housing, footpaths, lighting and education and health facilities. However, although KIP design standards have reduced the risk of fire in some areas, the use of modern flammable building materials and overcrowding have increased that risk. Moreover, narrow footpaths do not allow fire truck access to interior areas. *Kampung*s with an improved drainage infrastructure sometimes empty waste water into areas that do not yet have a drainage system. The improved infrastructure was not always effectively integrated with the broader infrastructure.

ECONOMIC

- KIP improved the quality of domestic living in Indonesian urban areas at a low cost of investment, ranging from US$ 118 per person in Jakarta to US$ 23 in smaller cities (1993 US dollars).

SOCIAL-CULTURAL

- Inadequate operation and maintenance is one of KIP's weakest points overall. The main environmental problem (in 1992) was blocked drains. The practice of dumping rubbish and sewage into canals and rivers causes backups. The attempt to improve solid waste management had mixed results. Residents prefer not paying for garbage collection services, and dump their waste on many informal landfills. This practice causes disease and water contamination.
- Almost 80 percent of the residents who were consulted and actively participated in planning and implementation found environmental conditions to have improved after KIP. Residents with little involvement were not as enthusiastic: only about half thought that KIP had improved environmental conditions. These findings indicate that consultation generally leads to participation, and that participation generally resulted in greater satisfaction with KIP results.
- An important outcome was the spillover effect: the KIP experience served as a prototype for investment and improvement in other areas. Other socio-economic indicators in non-KIP areas (those not targeted for improvement) have caught up with those in KIP areas.

The case of KIP proves that active involvement of a community determines the success factor of a housing project. The approach to the lowest level of a housing organization, by allowing and accommodating the inhabitants to administer their own housing facilities, is an appropriate method for obtaining sustainable housing.

4.3 Eco-House Experiment of Sepuluh Nopember Institute of Technology (ITS), Surabaya

The ITS Eco-House project, which was started in 1996 by the Ministry of Construction (MOC) and the Infrastructure Development Institute (IDI) of Japan, was intended to transfer technologies related to passive solar systems to Indonesia. Research on the Eco-house started end of July 1998, when the house was finished and handed over to IDI/ITS. After the monitoring devices were installed, an official observation research started in November 1998.

The Eco-house was designed as a collective house for the Indonesian climate (humid tropics), which basically refers to the concept of *Kasun* (or *Kampung Susun*, a communal living space that is built vertically instead of horizontally, as in a *kampung*/village). The Eco-house is not a pilot project but an experiment, which focuses on the thermal conditions of the house.

The results of the ITS Eco-House observation research are: the effect of ventilating layers and heat-insulating materials (coconut fiber) are remarkable. Coconut fiber has good heat insulating properties and is recommended as an insulation material. The effect of the Circulating-Water Radiant Cooling

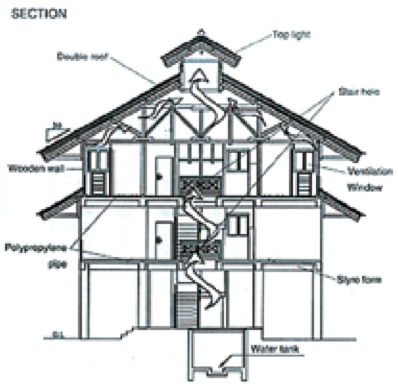


Fig. 4.5: The front part of ITS Eco-House in Surabaya
Fig. 4.6: Cross-section of ITS Eco-House

System depends on the temperatures of the well water used. The lower the temperature, the better the effect. The global temperature observed on the second floor is lower than the average temperature, probably because the rooms are more closed in by walls, floor and ceiling. Thermal comfort is determined by the inter-related elements of relative humidity, air temperature and air movement. From the design viewpoint, the cross-ventilation (open walls in the common rooms, windows for cross-ventilation in study rooms, and roof ventilation) worked well. However, the open-space design has the following disadvantages: hard wind flows indoors (sometimes bringing along rainwater), insect attacks (mostly mosquito), and a high security risk. A number of students and researchers have spent nights at the Surabaya Eco-House to conduct research on the house. Up to now, the Eco-house is still an object of observation and research, and also functions as a lecture or discussion room.

Corresponding to the seven aspects of sustainability, the ITS Eco-House can be analyzed as follows:

ENERGY
- The house was built according to the principles of a passive design strategy, which means that the indoor temperature and lighting are conditioned naturally as much as possible, therefore minimizing the use of energy-consuming devices.

MATERIALS
- The house was built using locally produced materials.
- The double-layered roof is made of a heat-insulating material consisting of coconut fiber.
- A concrete floor slab with big thermal capacity is utilized as a cooling system.
- Several parts of the Eco-house are left unfinished, or made knock-down (easily re-assembled), for the purpose of observation and research.

WATER
- Water is drilled from beneath the building for the needs of the dwellers, after which it is recycled and re-used.
- The water installation is buried inside each floor to circulate water pumped from the well in order to cool the house.

Table 4.3: Characteristics of the ITS Eco-House

	CHARACTERISTICS OF THE ITS ECO-HOUSE
Skeleton-Infill-Type Construction	The primary structure of the building (the skeleton) is a concrete construction with long-term durability; partitions and exterior (infill) are subject to wishes of residents in order to be able to involve them in the decision-making process.
Floor planning that fits regional lifestyles	The design is wider in comparison to conventional collective housing, giving it a feeling of spaciousness. In the meantime, maximum privacy is ensured in parts for exclusive use.
Application of Passive Cooling Technology	The building employs the following strategies: - double roofing, windows and outer walls for insulating solar heat - commonly shared open space arrangements - ventilation and natural lighting - ventilation channels in private sections - cold storage by night ventilation - a radiant cooling system by water circulation: a polyethylene pipe was buried in the concrete floor slab to circulate well water for achieving a radiant cooling effect. The well water is kept in an underground tank beneath the ground floor and is circulated by a solar-generated pump. The circulated water is re-used for flushing toilets and sprinkling.

INDOOR ENVIRONMENT
- Comfortable indoor thermal conditions can be achieved. However, there are also disadvantages to the openness of the house, such as hard wind flows, insect/mosquito attacks and high security risks.

SURROUNDING ENVIRONMENT
- The house was built on a relatively open site, a different situation from urban houses, which are built close to one another. Therefore any impact of this eco-house to the surrounding environment, or vice versa, cannot be considered to be the same when the Eco-house would be located in an urban area.

ECONOMIC
- The house was built on the initiative and with funding of the Japanese government (the Ministry of Construction, the Infrastructure Development Institute). Maintenance of the house is being taken care of by the partner institution, the host of the Eco-house, ITS.

SOCIAL-CULTURAL
- The Eco-house was built according to a design for communal housing by Prof. J. Silas, and emphasizes the needs and lifestyles of regional communities. However, it should be noted that an existing residential building designed by Silas, which is similar to the model of the Eco-house, was not successful in accommodating the need of its occupants to make social contacts. This problem occurred since the intended space for social purposes at the building failed to perform its function. The central hall which was supposed to serve as a meeting area is deserted. The main goal of this building is the efficient use of natural light and air, to which the residents were expected to adapt (van Dorst, 2005).

Table 4.4: Analysis of the ITS Eco-House according to the seven aspects of sustainability

ASPECTS OF SUSTAINABILITY	ANALYSIS OF THE ITS ECO-HOUSE
ENERGY	Using a passive solar design strategy that minimizes the use of energy-consuming devices.
MATERIALS	Local materials, roof of coconut fiber (heat insulator), concrete floor as a cooling system.
WATER	From a spring beneath the building, recycled and re-used; water installation inside each floor to cool the building.
INDOOR ENVIRONMENT	Comfortable indoor thermal conditions. Disadvantages: hard wind flows, insect/mosquito attacks and high security risks.
SURROUNDING ENVIRONMENT	Situated in an open space, unlike a dense urban area.
ECONOMIC	Initiated and funded by the Japanese government, maintained by the host institution (ITS).
SOCIAL-CULTURAL	The design emphasizes the needs and lifestyles of regional communities. However, an existing similar housing model has not yet succeeded to prove its capability to accommodate the social needs of its residents.
MISCELLANEOUS	Several parts of the Eco-house are left unfinished, or made knock down, for the purpose of observation and research. The house is still used for experiments and research activities.

4.4 Eco-House Resort of Environmental Education Center (Pusat Penelitian Lingkungan Hidup/PPLH) in Seloliman, East Java

PPLH Seloliman is an environmental education centre, located on the slopes of a volcano in East Java. It was established in 1990 with funding from, among others, the World Wildlife Fund (WWF) and the German government. PPLH, in its 3,7 ha site, consists of eco-buildings with various functions, mostly to support environmental education purposes, such as a library, a seminar 'theatre', simple laboratories, a restaurant and guest houses. It also maintains its own medicinal, spice, fruit and vegetable gardens, ponds and uses appropriate technology for energy and wastewater treatment.

Corresponding to the seven aspects of sustainability, the PPLH Eco-houses (guest houses and dormitories for larger groups) can be analyzed as follows:

ENERGY
- The houses were designed very open, therefore natural lighting can easily penetrate the space. There is no need for electricity except for a couple of light bulbs for the evenings. Without air conditioner, the indoor temperature is already comfortable, also due to the location at 700 m above sea level.

MATERIALS
- The houses were built with materials from local resources.

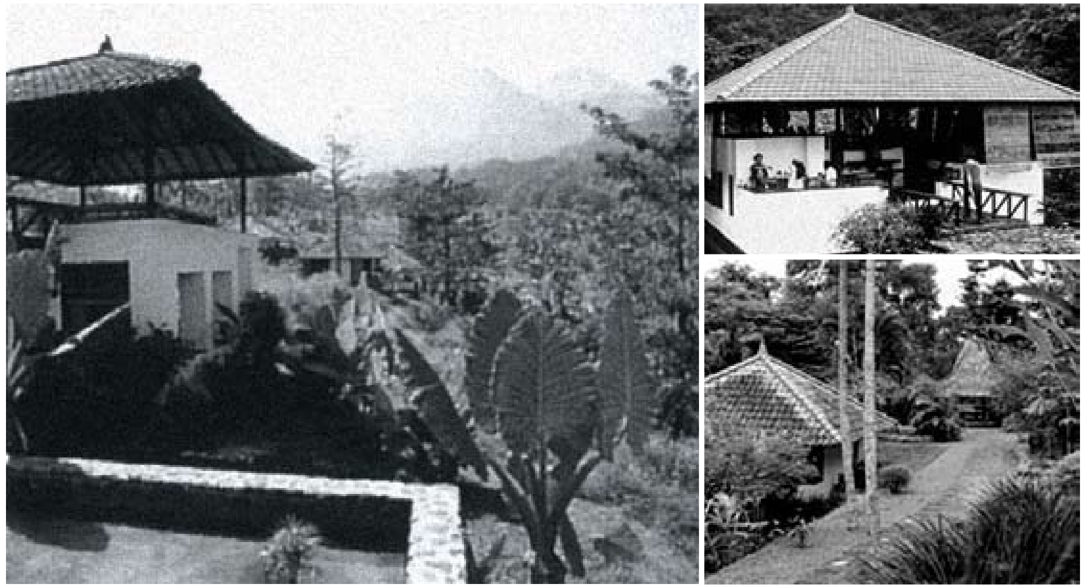


Fig.4.7: A view showing the restaurant (on the left side), one of the main buildings at PPLH Seloliman, and smaller buildings (lodging houses). Fig. 4.8: Entrance to the restaurant, a building surrounded by a fish pond. Fig. 4.9: The internal area of PPLH resort, showing a path between cottages and among plantations

WATER
- The tap water is taken directly from a spring and has drinking quality.
- The water is re-cycled in a simple water insulator.

INDOOR ENVIRONMENT
- Insect/mosquito attacks that usually become unbearable in the evenings are overcome by hanging mosquito nets above the beds, which is maybe not a proper solution. The use of insect/mosquito repellent in any form is not recommended, since they produce various kinds of waste and their substance contaminates fresh air.
- The cleaning agents used to clean the house, dishes and laundry are natural materials taken from local resources, therefore they produce no toxic waste and can easily be returned to the surrounding soil.
- The houses are located far away from the main road and the city, therefore there is no noise-pollution coming from vehicles, radio, TV or other household appliances.
- The principles and details of the PPLH Eco-houses and their operation (for example, the use of natural cleaning agents) are a good reference for urban eco-houses.

SURROUNDING ENVIRONMENT
- The houses are built in harmony with the natural surroundings, hardly changing the landscape and still providing water absorption areas.
- Some buildings were built surrounded by artificial ponds with no component really attached to the soil across the building. The purpose of this is to avoid insects, especially ants, to crawl into the building.
- The Eco-houses of PPLH are suitable only as eco-tourist resort. The designs of the houses are not applicable to private houses in urban areas, since the openness invites high security risks.

Table 4.5: Analysis of the PPLH Eco-houses (guest houses and dormitories for larger groups) according to the seven aspects of sustainability

ASPECTS OF SUSTAINABILITY	ANALYSIS OF THE PPLH ECO-HOUSES
ENERGY	Natural lighting in the daytime, light bulbs in the night, no air conditioner.
MATERIALS	Local resources.
WATER	Taken directly from a spring, has drinking quality, recycled in a simple water insulator.
INDOOR ENVIRONMENT	No insect repellent (uses nets), natural cleaning agents, no noise pollution (due to location). Some of these examples are applicable to an urban setting.
SURROUNDING ENVIRONMENT	Built in harmony with the landscape, some were built surrounded by artificial ponds to prevent insects from entering the building through soil. Suitable as a resort, too risky for an urban situation.
ECONOMIC	PPLH should support itself financially.
SOCIAL-CULTURAL	Fits well with the neighbouring villages, whose inhabitants can make extra income by working for/with PPLH

ECONOMIC
- PPLH Seloliman is not a government institution, nor a commercial organization, therefore it should support itself financially.

SOCIAL-CULTURAL
- PPLH Seloliman fits well with local people at the neighbouring villages, who can even make extra income working for PPLH or selling their harvests.

4.5 Banjarsari Village in Cilandak, South Jakarta

Banjarsari, a 1,365 ha village in West-Cilandak, was established in 1970. Located next to Pesanggrahan River, Banjarsari is a potential flood area; therefore its inhabitants need to be aware of the importance of keeping a clean, non-polluted, environment. An Environment Committee, emerging from the *Kelompok Wanita Tani*/ KWT (Farmer Women Group) of Banjarsari, initiated waste-management and greening issues for the village. Since 1990, Mrs. Bambang Wahono has been leading her fellow villagers to reduce, re-use and recycle their waste and to replant their surroundings. Banjarsari village has been successfully producing valuable consumer goods made of paper waste and processing compost made of bio-waste. Since 1996, Banjarsari has become a 'model village' for UNESCO.

Corresponding to the seven aspects of sustainability, the Banjarsari Village can be analyzed as follows:

ENERGY, MATERIALS, WATER
- In general, the aspects of energy, materials and water of housing in Banjarsari are not exceptionally different from the average *kampung* in Jakarta.

Fig.4.10: Training about recycling in Banjarsari

INDOOR ENVIRONMENT
- There are no official data on disease caused by unhealthy indoor circumstances; it can be assumed that the households in this village are aware of the 'healthy house' concept.

SURROUNDING ENVIRONMENT
- The initiative to maintain a healthy environment has resulted in a rule to have at least 20 plants in each household, with which the inhabitants positively agree. Having living green plantations around the housing suggests fresh air and a clean ambience, since plantations are generally air-pollutant absorbents. It can be assumed that the surrounding environment is relatively clean, since the inhabitants organize a monthly village-cleaning program during which sewers are cleaned and trees are planted.

ECONOMIC
- Banjarsari inhabitants are of middle- and lower-income groups of society. The activity to maintain their own paper- and bio-waste actually adds to their income, for which reason they are willing to keep up this activity. The village has an 'environmental kiosk' that sells their products (to visitors of Banjarsari village and fellow Banjarsari inhabitants), such as art paper and tableware (made of recycled paper-waste) and bags of compost and fertilizer (made of household bio-waste).

SOCIAL-CULTURAL
- The relationship among inhabitants of Banjarsari village is exceptionally solid, especially since they have ongoing communal projects that are beneficial not only for the community itself, but also for the environment.

MISCELLANEOUS
- Banjarsari has a person who leads and urges the villagers to participate in the environmental program. This person, Mrs. Bambang Wahono, has been conducting a personal approach to encourage her fellow villagers, building up a sense of belonging in each inhabitant, from young to old; she also initiated regular training sessions on waste processing. The strong relationship among Banjarsari village dwellers enables the establishment of communal facilities.

Table 4.6: Analysis of Banjarsari Village according to the seven aspects of sustainability

ASPECTS OF SUSTAINABILITY	ANALYSIS OF BANJARSARI VILLAGE
Energy	Not exceptionally different from other *kampung*s in Jakarta
Materials	
Water	
Indoor environment	Healthy House concept
Surrounding environment	Min 20 plants per household, monthly cleaning (including sewers) and planting trees
Economic	Activity of handling paper and bio-waste is adding to the income, a 'green kiosk' that sells recycled products and bags of compost and fertilizer
Social-cultural	Exceptionally solid relationship that supports communal projects Banjarsari has a very dedicated leader/motivator

4.6 Overall Analysis

The first example, the Healthy Housing campaign, is a governmental effort to encourage people to maintain their own domestic environment. It is a guideline, which makes it different from the rest of the examples that are actual housing projects and activities. It provides basic requirements (materials and minimum standard of measurement) for a house, that can be referred to in the formulation of Indonesian sustainable housing requirements (see Chapter 5).

The rest of the examples provide a demonstration of how a sustainable house in Indonesia may perform. However, the cases of ITS and PPLH are not fully applicable to common housing in dense urban areas, due to the following points:
- Security reasons: the ITS and PPLH houses have 'open' designs that invite high security risks if applied to private housing in a crowded city.
- Surrounding conditions: the ITS and PPLH houses were not built nearby any road or other houses, which would otherwise contribute air and noise pollution.
- Financial capital: the building of ITS Eco-house and PPLH resort were each built on a secured capital investment (their sponsors, MOC & IDI for ITS and WWF & the German government for PPLH, have committed to finance the building expenses).
- Continuous maintenance: Maintenance of the ITS Eco-house is taken care of by ITS, the hosting university, while PPLH depends on a self-financing system and donators. These systems are different from those of private residence maintenance.

Successful examples that are applicable to housing in dense urban areas are:
- The use of a passive solar design strategy for residential buildings. This strategy allows sunlight to light the house in the daytime, and wind or fresh air to circulate within the house and cool the indoor temperature, therefore reducing the use of energy generating devices for lighting and air conditioner.
- The use of local natural materials as heat-insulators (such as coconut fiber for the ITS Eco-house).
- The use of natural materials reduces waste of synthetic materials and the use of local materials reduces the energy due to transportation.

- The purification and re-use of water for domestic purposes.
- The use of natural cleaning agents.
- The practice of community participation in reducing waste and processing garbage into commercial products. A solid community co-operation will lead to a positive development of the domestic environment, and becomes a potential area for communal facilities application.

CONCLUSIONS

On the one hand, financial capital is not a strong factor in Indonesia;[5] on the other hand, social-cultural traditions in Indonesia (i.e. kinship relations, *gotong royong*) are still strongly believed in and being practiced in daily life, which influences domestic activities as well. Therefore it is essential to include *economic* and *social-cultural* aspects into the analysis of sustainable housing in Indonesia, due to their significant role in the decision making of housing projects.

Three points from these examples, which this thesis promotes as the most effective options for sustainable housing implementation in Indonesia, are:

- That the implementation of the concept of sustainability in the field of housing can actually improve and maintain the quality of environmental conditions. This point is particularly visible in the case of PPLH Seloliman, which buildings were made and maintained on the basis of sustainable practices.

- That the involvement of the inhabitants in their own housing project is proven to be effective in assuring a continuous maintenance of their domestic environment. This point is particularly evident in the case of KIP, where participation of a majority of housing occupants determined the success level of the program.

- That decisions that are made locally and motivation and initiative from the basic level of society (family, neighborhood) provide the best sustainable housing solutions. This point is remarkably apparent in the case of Banjarsari, where local initiators have been mobilizing their fellow neighbours and other local resources towards a healthier, sustainable domestic lifestyle. For the present, this is an effective solution for the majority of dense urban areas in Indonesia, whereas the application of advanced (sustainable housing) technology is not yet feasible.

These points are included in the formulation of a set of requirements and guidelines for residential housing in Indonesia in the following chapter. The sustainable housing cases in Indonesia are given scores of 'level of sustainability' using the DCBA method, with the purpose of demonstrating the application of the method.

Notes

1. *However, the focus of* Perum Perumnas *is now back to urban development, since the government takes over the infrastructure development and the private sector becomes more active in housing development (*Media Indonesia*, 14 March 2003).*
2. *The abbreviation 'RSS', which used to stand for* Rumah Sangat Sederhana *(very modest house), was changed into* Rumah Sehat Sejahtera *(healthy prosperous house) by Prof. Dr. H. Haryono Suyono, the State Minister of Population and Head of BKKBN (*Badan Koordinasi Keluarga Berencana Nasional*, or the National Family Planning Coordinating Board) in 1993-1998. The purpose was to convince the majority of the people that a healthy living environment can be created even in the most modest housing conditions (Komarudin, 1997, pp. 292). At present, 'RSS' is commonly known as* Rumah Sehat Sederhana*, or healthy modest housing. The concept of 'healthy housing' is actually overlapping with the concept of RSS, which, coincidentally, also inclines to a sustainable housing practice.*
3. *See Appendix C for a general technical guideline for healthy modest housing, which is still being referred to up to today.*
4. *The lowest-income is 150.000 IDR to 200.000 IDR (about 11 - 15 EUR) per month.*
5. *According to the World Bank estimates, during 1997-2003, 17 % of Indonesia's population lived the below national poverty line and is defined to be living in poverty. Indonesia is characterized among the lower middle-income countries of the world. http://www.economywatch.com/world_economy/indonesia/*

5. SET OF REQUIREMENTS & GUIDELINES

This chapter ends the first theoretical part of this dissertation by presenting a set of requirements for sustainable housing in Indonesia and guidelines for residential housing in Indonesia. The set of requirements, which answers Research Question 1, proposes a number of minimum necessities that should be provided in order to achieve a sustainable housing condition in Indonesia. The guidelines, which answer Research Question 2, are presented as a DCBA table, serving as discussion material for all parties involved in a housing project.

5.1 Set of Requirements for Sustainable Housing in Indonesia

The answer to the first research question: *What constitutes sustainable housing in Indonesia?* comes in the form of a set of requirements that needs to be fulfilled in order to achieve sustainable housing conditions in Indonesia. This proposed set of requirements contains minimum necessities which, if put together or conducted alternately, establish sustainable housing in Indonesian conditions. The set of requirements is outlined in a table and elaborated afterwards, according to the sustainability aspects of a building as specified by Hendriks (2001), extended with economic and social-cultural aspects.[1]

The set of requirements for sustainable housing in Indonesian (see Table 5.1) can be elaborated as follows:

ENERGY

- *Apply a passive solar design strategy*: Attempts to decrease energy use in a domestic environment begin with the design of the housing itself. A passive design strategy for warm-humid climates attempts to reduce the use of electricity for lighting and to avoid the use of air conditioners. The design involves the interaction of daylight, radiation and ventilation: the design should allow sunlight while avoiding heat, and should allow wind into the building while avoiding outdoor heat (Pandjaitan, 1998).
- *Increase the use of alternative energy sources*: Another option is to promote the use of alternative energy sources (other than oil-based). One of the potential alternatives is solar cell technology (photo-voltaic electricity/PVE), especially for application in remote areas where electricity grids are not available. 60% of PVE components are already made locally, thus the application of PVE technology means a job opportunity for local PVE components industries. PVE is so far the most appropriate alternative since it has a low maintenance cost, a durable lifetime and an unlimited source of energy (Dasuki & Djamin, 2001). Aside from PVE, micro-hydro technology is also an alternative, which can be applied as long as its energy source, flowing water, is available. Wind energy is also applicable, but only in specific areas in Indonesia. Recent research by the Indonesian Agency for the Assessment and Application of Technology (BPPT) and Energy research Center of The Netherlands (ECN) Amsterdam has lead to the development of multi-fuel cogen, a mini electricity generator that can be operated by using several biomass energies.
- The application of alternative energy sources for housing is appropriate as long as its whole process is geographically suitable and within budget and maintenance capability of the users (local people).

MATERIAL

- *Employ construction principles for wet-tropical areas*: According to Santosa (2001), the main construction principles for wet-tropical areas are: *construction materials* that are able to hold heat and then release it and a *construction designed* so that it can release the rest of the heat (for example by ventilation). People have preferences in choosing materials for their houses. The preferences are different among low-income populations, higher-income populations and developers (REI, 1991). Local materials for building purposes are being popularized to reduce prices. Light building materials (i.e. bamboo for walls) are actually a good choice because they do not store heat, which is suitable for regions with a small daily temperature range (Susilo, 1997).
- *Increase the use of alternative (local) materials*: A recent research at the Housing Research and Development Center (*Puslitbang Permukiman*) and BPPT on ecological building materials is proposing the use of bamboo as a building material, aimed at low-cost housing. BPPT and the Indonesian Science Institute (LIPI) have been developing bamboo panels for building purposes. Considering the condition of the Indonesian forests that are diminishing due to various causes, alternative materials to supplement or substitute wood are essential. Bamboo is known to be a competent material to supplement wood, regarding its technical and mechanical properties that resemble those of wood (Larasati, 2002). However, further research is necessary in order to investigate the sustainability aspects of the whole bamboo board production process.
- *Apply the modular co-ordination system*: Another approach to an environment-oriented housing technology is the modular co-ordination (Koordinasi Modular – KM) system, which means setting up uniform measurements for various building materials, components and elements. Advantages are increased production efficiency and reduction of waste of production materials. These advantages are especially significant in low-cost housing projects, where rapid, budget-tight development is needed.
- *Consider pre-fabricated building systems*: Pre-fabricated housing systems, a similar strategy to the KM system for building materials, was once introduced in Indonesia. However, it was not successful, since Indonesian house-owners prefer to be involved in the design of their own house. The same goes for uniformous low-cost housing: they are not considered desirable. However, it can be noted that pre-fabricated houses are an ongoing business. In Minahasa (North Sulawesi), Tomohon village has been producing knock-down traditional Minahasan houses made mainly of local wood, to be sold in Indonesia and abroad. These houses come in various models and, referring to traditional designs, are adapted to modern needs and facilities (water and electricity installations, private bathrooms, etc.). It is necessary to investigate the environmental impact of this housing industry (from building to transporting, rebuilding, operating and maintaining the house), but it may be an interesting model in specific circumstances.

WATER

- *Re-use water*: It is important to provide housing areas that can absorb and store water, so the water can be recycled and re-used naturally. But such areas are becoming more scarce, while water quality in some dense urban areas is deteriorating continuously. Water with drinking quality becomes very precious and thus costly. Unless precautions are taken, clean water will become impossible to acquire. Re-using water is one of the proposed solutions. Used water (from cooking, bathing, etc.), or 'gray water', can be used again to flush toilets or to water plants/gardens. According to Yudiarti (2001) water re-use in private residences should be proposed as a regulation. However, the implementation and consequences of water re-use in Indonesia have to be thoroughly investigated, considering the health risks that can occur due to undisciplined operation.
- *Harvest rain-water and purifying surface water and soil water:* Another solution is popularizing rain-water harvesting or purifying surface water (river, dam, lake) and soil water. Simple methods, using common tools and materials are available, therefore only promotion and proper management are needed to establish a communal water center for domestic activities.

INDOOR ENVIRONMENT

- *Popularize and implement the standards in Healthy Housing campaign*: According to Wijayanti (2001), research on housing in Indonesia does not yet regard the issue of indoor hazards as a priority, e.g. cooking inside the house without proper ventilation.[2] So far, the 'healthy house' campaign – especially directed to the middle- and low-income groups of society – has included the discussion of clean ambient or surrounding air, besides optimal energy and water usage. The control of 'healthy house' implementation is most effective at the lowest level of government: supervised by the village chief (*kepala desa*). Therefore, community training and courses about the 'healthy house' are also most important at village level.

SURROUNDING ENVIRONMENT

- *Improve housing infrastructure*: It is common that the infrastructure (environmental services, such as site and water) is not planned beforehand and is installed only when the housing is built. This often causes unreliably or spontaneously established housing facilities (private water wells/pumps, electricity grids, etc.), which results in uncontrollable consumption of energy and resources. According to Argyantoro (2001), violations of housing regulations have been contributing to the lack of housing, especially for low-income people. Therefore, besides improving the planning of housing development, regional governments should put a priority on reviewing the existing housing policies or be more strict about their implementation.
- *Stimulate self-initiated communal activities or maintenance*: Concerning the Surrounding Environment aspect, most of the solutions may come from the regional government level, but it is also important that communities play a role in improving their own neighbourhood. An overall healthy environment is easier to achieve if all members of the neighbourhood participate, especially when the people know each other quite well within the community. This subject will be discussed further under the social-cultural aspect.

ECONOMIC

- *Upgrade facilities of existing settlements*: Housing for high-density population areas has been an urgent problem up to this moment. In order to cope with this problem, subsidized low-cost housing or *Rumah Sederhana/Rumah Sangat Sederhana* (RS/RSS) and high-rise buildings (social housing/apartments) have been built, but they did not succeed to meet the requirements.[3] A potential solution is upgrading facilities of existing low-income dwellings in urban areas, which has been realized by KIP. KIP requires a low-cost investment,[4] while improving communities and environments of KIP areas and even having positive impact on non-KIP areas.
- *Facilitate self-supportive financial system:* If people in the community take part in financing the development of their living environment, they will have a sense of involvement and will maintain their environment with care. Agencies were created by the government to direct development and investment activities, in particular the National Urban Development Corporation (*Perumnas*) which manages low-cost housing development, and the State Savings Bank (*Bank Tabungan Negara*/ BTN) which is allowed to introduce mortgage-lending operations.

SOCIAL-CULTURAL

- *Consider the gap among the levels of society*: The gap between the groups of society is quite wide; not only in respect of their economic situation, but also in social behaviour and attitudes. They have different mentalities and perceptions towards the same subjects. According to Anwar (2001), the subject 'ecology' or 'ecological housing' is understood without any problem by the upper-class of society (but do they also make more expenses for ecological reasons?), while it is not easily understood by middle- and lower class society.

Table 5:1: Set of Requirements for Indonesian Sustainable Housing

ASPECTS OF SUSTAINABILITY	SET OF REQUIREMENTS FOR INDONESIAN SUSTAINABLE HOUSING
ENERGY	Apply a passive solar design strategy Increase the use of alternative energy sources
MATERIAL	Employ construction principles for wet-tropical areas Increase the use of alternative (local) materials Apply the modular co-ordination (*koordinasi modular*/KM) system Consider pre-fabricated building systems
WATER	Re-use water (as immediately as possible) Harvest rain-water and purifying surface water and soil water
INDOOR ENVIRONMENT	Popularize and implement the standards of the Healthy Housing campaign
SURROUNDING ENVIRONMENT	Improve housing infrastructure Stimulate self-initiated communal activities for maintenance, etc.
ECONOMIC	Upgrade facilities of existing settlements Facilitate self-supportive financial systems
SOCIAL-CULTURAL	Consider the gap among the levels of society Take into account the Indonesian communal way of living

- At city level, *knowledge problems* occur: if somebody who used to live in a traditional village brings his habits and lifestyle to an urban house and environment, he will create environmental problems (for example, throwing garbage right away into the river). At village level, *quality problems* occur: if somebody who used to live in the city brings his habits and lifestyle to his rural house and environment, he will create problems mostly with the facilities that support housing. In short, a house and its surroundings should be able to accommodate the (growing) diversity of needs and lifestyles of their dwellers.
- *Take into account the Indonesian communal way of living*: According to Silas (2001), one of the problems of social housing in Indonesia is the lack or unavailability of communal space for the dwellers to socialize. Indonesian people are not used to an individual way of living. If housing includes a communal space, the dwellers will feel better. Another problem is the location of social housing, which is mostly far from the city center where the dwellers work. They have to make extra expenses for transportation. An example can be taken from Banjarsari village in Jakarta. If people within a community have a close relationship and are aware of their environment, they can manage to establish communal facilities for their own benefit. These activities heighten the self-esteem in the village dwellers, which urges them to achieve better results. Apart from the personal approach by an initiator, regular training is necessary in order to refresh the motivation of the community. This kind of community is ideal to start the establishment of more elaborate communal facilities such as energy generation and water management.

FURTHER INVESTIGATION

On the basis of the evaluation of the cases presented in this dissertation, it can be concluded that further research should be aimed at the following potentially effective strategies to achieve sustainable housing in Indonesia:

ENERGY

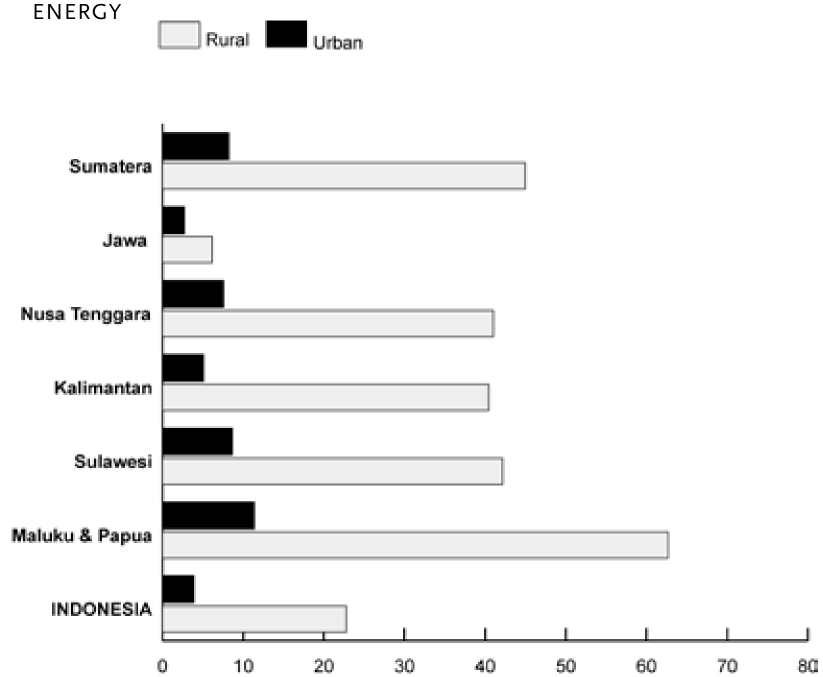


Fig. 5.1: Percentage of households using non-PLN for lighting (2003)
In 2003, 22,8% households in rural areas and 3,9% households in urban areas in Indonesia did not use the service of PLN

The abundance of natural resources in Indonesia is a good starting-point for finding alternatives for energy provision and building materials. Sustainable energy sources, such as solar, geothermal, wind and micro-hydro energy, have to be investigated and applied where possible.

MATERIALS

Humidity is a significant factor that deteriorates building materials in Indonesia, which makes it necessary to enhance their durability through extra maintenance efforts. Further research on local building materials, such as coconut fiber and bamboo, needs to be conducted to determine their ecological, economical and social-cultural advantages, and whether their production and application are feasible for housing development in Indonesia.

WATER

Simple technology of water purification can be offered as a solution, along with a rain-water harvesting system, which can be established as a communal facility.

INDOOR ENVIRONMENT

Natural cleaning agents (detergents, soap, etc.) for household activities made of local plants can be processed and used according to traditional methods. If these materials are popularized, their propagation (as pollutant absorber) and usage (that produce natural waste) will contribute to a cleaner environment.

Fig. 5.2: A traditional Minahasan house
Source: Minahasaraya.net

SURROUNDING ENVIRONMENT

The control of 'healthy housing' implementation is most effective on village level. The conditions in one village will have an impact on its surrounding villages, therefore co-operation among villages is necessary. Village improvement might be aimed at safety towards fire risk (due to high population density) and hygiene quality (due to domestic living habits concerning waste-water and garbage treatment).

ECONOMIC

The housing industry in Indonesia is commonly labour intensive. Rapidly growing housing demands and housing development provide job opportunities, especially for producers of building materials. Up to today, the inexpensive labour in Indonesia is an advantage, considering it is an affordable factor in housing projects. It should be noted that the Indonesian people still have the advantages of an informal economy, also with regards to building activities.[5] For example, people in a village voluntarily help a neighbour build his house, therefore no or very few paid building workers are needed. Or, all villagers together build communal facilities, such as a water well, a religious building, or a night watchers' quarter. This type of social behaviour, which hardly exists in developed countries, actually reduces the cost of building operations. Therefore its application is recommended and should be encouraged whenever possible.

SOCIAL-CULTURAL

Indonesian people are not used to an individual way of living. Therefore they always need a communal space within their domestic environment, which leads to the necessity of planning a communal space for every housing project. The control of 'healthy housing' implementation is most effective at the lowest level of regional government: village. Therefore a good relationship among the village community is necessary. Initiators and regular training are also factors that encourage villagers to maintain their 'healthy housing' environment. A change of attitude in domestic activities is necessary for people who have to adapt to a different living environment from where they used to live.

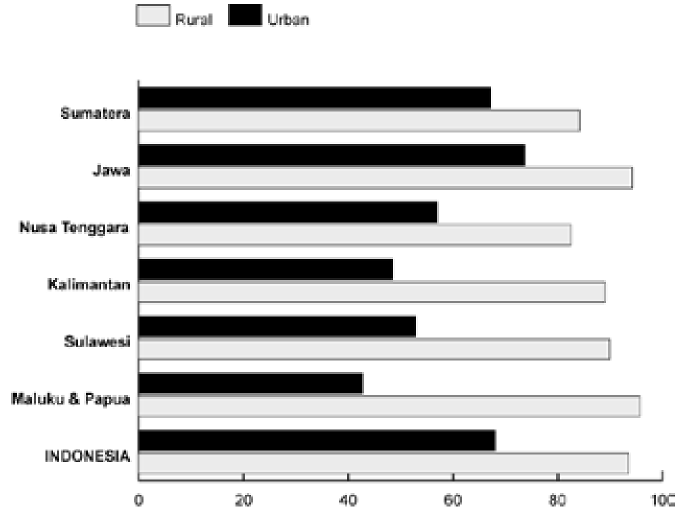


Fig. 5.3: Percentage of households using non-piped drinking water (2003)
A high percentage of households in Indonesia still rely on still/flowing water (springs, wells, rivers) from surrounding or local areas of their housing for their domestic needs

MISCELLANEOUS

Rules and regulations: It takes from 7 months to one year to acquire a building permit in Jakarta, covering the planning, land use, land certification, building permit and occupation phases (see Appendix F for the process to acquire a building permit and Appendix G for the development permit procedure). If the location of the proposed house is included in the regional plan as a residential area, the permit would very likely be issued without any problem. If the design of the building fits the requirements of the local regulations (regarding i.e. the number of stories, height of fence), the building permit is expected to be approved without difficulty. However, what has been happening in reality is not always in accordance with official regulations, due to lack of control. High-rise buildings were erected where a public park and greenery were supposed to be, houses were built where water reservation sites and a natural coastal barrier existed, a commercial district was established in an area which facilities were planned to support and serve only residential houses. This kind of situation leads to unfavourable conditions (i.e. over-extraction of groundwater, lack of green open space), which leads to various 'natural' disasters (i.e. sea-water intrusion, high level of air pollution, flooding during rain season).

Another occurrence of frail control of housing regulations concerns the efforts to provide housing for the low-income groups in dense urban areas. Housing subsidies and ownership of a public housing unit are actually aimed at the low-income groups (see Appendix H which describes policy and program of housing subsidies, which are provided for people whose income is below 1.300.000 IDR per month).[6] However, people who are not entitled to these facilities have managed to gain access and ownership, sometimes due to the fact that the intended inhabitants, who are unaccustomed to (and are uncomfortable with) the public housing lifestyle, prefer to sell their units and move back to slum settlements. This situation clearly disrupts the efforts to provide appropriate housing for the low-income groups. One way to cope with this problem is by designing public housing that can accommodate the needs and lifestyles of the aimed group of inhabitants and which create a sense of ownership with the inhabitants towards their domestic facilities. Beforehand, potential inhabitants should be able to communicate their wishes and demands to the housing developer and have control

Fig. 5.4: A street of a KIP village, which also functions as a place to socialize (Photo courtesy Professor Jeff Kenworthy, Murdoch University, Western Australia). Fig. 5.5: Front part of a house in a KIP village, which is actually also a public pathway, a market stall, a meeting place (Photo courtesy Professor Jeff Kenworthy, Murdoch University, Western Australia)

to a certain extent over the building process.[7] Another way to handle this problem is by conducting a strict law enforcement to control policy violators and to improve the existing regulations,[8] which have not given enough room and stimulation for the private sector and communities to participate actively in many government-initiated projects. On that account, an improved policy should encourage co-operation among the public and private sectors, while also involving local communities. There should also be co-operation among regional governments in infrastructure planning, since (environmental, economical and social) conditions in one area will always have an impact on its surrounding areas.

APPROPRIATE TECHNOLOGY

Appropriate technology is a choice of technology that does not burden or harm the environment, should be affordable by its users and should enhance the confidence of the local community (Budgett-Meakin, 1992). A method to conduct a sustainable housing project, therefore, should allow community participation, respect local natural resources and materials, acknowledge skills and capacities of the local community and attempt to discover local solutions. Examples of application of appropriate technology in the form of simple communal domestic facilities, where inhabitants can participate and benefit from direct advantages, are:

- A compost production site, where people can gather and process their household (bio)waste into compost or fertilizer, and later use it for their own plantations and/or sell the rest. This is particularly effective when applied to a village scale, like in the case of Banjarsari (see Chapter 4).
- A rainwater harvester and a water purifier, which collect and process rain water for domestic purposes at the household level. Rainwater harvesting employs simple technology, is affordable and user friendly, as mentioned under the appropriate technology item of the *2006-2015 Water, Sanitation and Hygiene Strategy* by the Water Supply & Sanitation Collaborative Council (2006).
- A solar energy generator, which functions as a reliable energy source, especially in (remote) areas that have no access to the state's electricity grid. Survey of Energy Resources in 2004 by the World Energy Council[9] mentions the first successful demonstration of rural electrification using Photo-Voltaic Electricity (PVE) occurred in 1989 in Sukatani Village (Java). The government has also set targets for the installation of PV systems for a variety of applications: pumping stations for rural clean water supplies, TV repeaters, fishing boat lighting, grid-interconnected housing, etc. Many local PVE projects are sourced through government-instituted village cooperatives, which participate in the installation, maintain the systems thereafter, collect payments and act on behalf of the individual end-users with banks and government.

CONCLUSIONS

- Government-initiative improvement programs gain success only with active support and participation of the local communities involved.
- Existing housing rules, regulations and guidelines are quite adequate, but the realization needs a stronger and stricter policy in order to gain the proposed results.
- Self-supportive & self-initiated communal activities in domestic environment prove to be very solid and sustainable. Local leadership is necessary to stimulate fellow (village or housing) residents.
- Results from academic and professional experiments and practices in the field of sustainable housing performance can and should be applied to actual housing projects in dense urban areas.
- Indonesia possesses potential conditions that are different from developed countries, which support the achievement of appropriate technology application in the field of housing. These conditions are:
  - *Environmentally sustainable*. The warm-humid climate of Indonesia actually allows minimum energy use for housing, if a passive-cooling design strategy is employed and if the building materials are chosen according to construction principles for wet-tropical areas. There is no requirement for extra energy for heating and insulation. Another potential is the great diversity and quantity of Indonesian natural resources, which gives an opportunity for the development of alternative energy applications. Electricity generation from solar cell technology (photovoltaic electricity) in remote areas (that are out of reach of the electricity grid) is one successful example.
  - *Economically sustainable*. Abundant human resources in Indonesia contribute to the reduction of labour expenses, therefore the housing industry (including building materials production) in Indonesia is commonly labour-intensive (also as to provide job opportunities). Another potential is the practice of an informal economy, whereby people in local communities work together voluntarily in building communal facilities, which reduces the cost of building operations.
  - *Social-culturally sustainable.* Indonesia has a communal way of living, where social contacts among neighbours are essential. This social behaviour is a strong foundation for the establishment of communal facilities and active participation in improving the domestic environment.

5.2 DCBA Guidelines

ABOUT THE DCBA TABLE

The purpose of the DCBA table is to serve as a guideline by providing discussion material which can be used by all parties involved in a housing project. The variables used for each topic correspond to the seven aspects of sustainable building. The D column represents the conventional version, or common situation, of present housing activities. The C column represents the first steps to correct the normal usage towards sustainability. Column B represents the efforts towards an ideal situation, and column A represents the most perfect situation. The process from D to A gradually changes into a higher level of achievement for sustainable housing.

WASTE: CLEANING AGENTS	
	
D Use commercial, chemical cleaning agents.	**C** Minimize the use of commercial cleaning agents and use natural alternatives whenever possible, such as using lavender instead of insecticides to repel mosquitos.

Fig. 5.5: A series of panels from a concept version of the illustrated DCBA booklet. This panel provides options for cleaning agents for the occupants, who can choose option D, C, B, or A, according to their preference and capability to fulfilltheir own wishes.

SCOPE

This DCBA guideline is only applicable to general residential housing, although, intermittently, might also touch the subject of urban planning issues. The discussion includes building elements (i.e. walls, ventilations, etc.), but excludes building details (i.e. piping, cables, wiring, etc.).

USERS

This DCBA guideline is intended for people who are involved in a housing project; especially for (potential) inhabitants who need to communicate their wishes and demands among each other and to other stakeholders in the housing project: government/policy makers, developers, inventors, contractors, architects, etc.

HOW TO USE

The points that are proposed in this DCBA guideline are suggestions of how to achieve a certain level of 'sustainability' in a housing project. The guideline provides four levels of options for each variable, where it is best to achieve the highest score possible. One housing project would score differently from another, depending on each project's specific conditions. This guideline is expected to rouse and stimulate discussions concerning the efforts towards an ultimate sustainable housing. A prototype of this DCBA guideline is produced as a separate booklet to supplement this dissertation, in a format that is ready to use.

Note: Table 5.2 is the first version of the contents for the DCBA booklet. Changes were made based on two usability tests during the production of the booklet (see Appendix I). The main differences between this version and the booklet version are:

WASTE: CLEANING AGENTS	
	
B Only use natural, bio-degradable cleaning agents.	**A** Self-produce and use natural cleaning agents

- the booklet uses daily language that can easily be understood by common, non-technical people or inhabitants who participate in a housing project discussion
- the themes in the booklet are divided under the 4Ps (People, Project, Planet, Prosperity)
- the themes in the booklet are arranged in a different sequence; the most inviting themes (under People) are placed at the front.

5.3 Application of DCBA Guidelines to the Existing Examples in Indonesia

The following table consists of the existing examples of sustainable housing practice in Indonesia, where each of their variables are scored according to the DCBA Guideline. The Healthy Housing campaign is also mentioned as one of the examples, which is different from the rest of the examples since it is a governmental campaign and not a concrete building project. However, it is included in this table in order to give an overview of its level in the DCBA guideline. From these scores we can see that each housing project has its own best points, specific to its conditions. The differences also occur due to the initiators of each project: the Indonesian government (for villages in urban areas), a non-government organization (for an environmental resort in a secluded mountain area), an academic institution (for an experimental building) and a community (for their own neighborhood). For instance, we can see that Banjarsari Village scores low in Energy, Materials and Water, because no significant improvement occurred. However, its score at the Social-Cultural variable is remarkably high, since its communal activities have acclaimed international recognition. Meanwhile the PPLH Eco-House scores fairly high in its physical performance, because they successfully applied the eco-house concept to their buildings.

Concerning the Energy and Materials aspects, PPLH and ITS – who apply similar strategies (natural lighting, local materials) – reach the same score. This can be achieved due to the purpose of their buildings, their location and accessibility to direct natural resources.

PPLH reaches the highest score concerning the Water and Indoor Environment aspects, also due to its location in a secluded mountainous area, which makes it possible to acquire clean water and maintain a clean, healthy indoor environment. Other cases, located in urban areas, have reached a high score due to their understanding of the Healthy Housing concept.

Concerning the Surrounding Environment aspect, only ITS shows a lower score compared to the rest, due to its current function as a lab of a university (instead of a residential building), which allows only assumption of its condition in a real dense urban area. PPLH improves the environment where it stands, while KIP and Banjarsari have positive spillover effects to neighbouring areas

Concerning the Economic aspects, all cases show average scores. Banjarsari reaches the highest score due to its self-initiated activities that, while improving the neighborhood environment, also creates new sources of income for the community.

In the Social Cultural aspect Banjarsari achieves the highest score for its remarkable self-motivated communal activities, which has received international recognition. It also has dedicated leaders/initiators, who are the main success factor behind Banjarsari's accomplishment. Their achievement also proves that the most effective performance of *gotong royong* (see Chapter 3) is at a neighborhood or village level, conducted by fellow inhabitants.

The Healthy Housing campaign has encouraged the use of natural lighting and indoor cooling and local material strategies, where it 'scores' the highest (B for both Energy and Material aspects) compared to other aspects. The rest of the Healthy Housing aspects show that the government's minimum requirements for housing aim at a slightly improved condition (C- or average level).

In general, KIP and ITS reach higher scores concerning technical issues, since they were in fact an improvement program and an experimental eco-house design, directed mostly at infrastructure facilities and application of a passive solar design strategy. Meanwhile, Banjarsari reaches higher scores concerning social issues, for its outstanding performance in managing and reinforcing its own (human) resources. Environmentally, PPLH scores above average due to its specified location and function as an environmental education center.

5.4 Conclusions

This conclusion chapter consists of two parts: the first part concerns the DCBA method, while the second part concerns the characteristics of different actors of sustainable housing practice in Indonesia in acquiring the highest scores for certain themes of the DCBA guideline.

CONCERNING THE DCBA METHOD USED AS A GUIDELINE AND DISCUSSION TOOL

The DCBA guideline gives opportunity for inhabitants and people who are usually left out of the chance to vote, to express their voice, state their demands. The usability tests of the DCBA guideline proved that this method is a comprehensive discussion tool (see Appendix I). According to the tests persons it is quite easy to use the illustrated guideline as a discussion tool, so the inhabitants can choose their preferences for their domestic environment. One cannot reach the highest score for every aspect; priority has to be set according to existing capabilities. Reaching the highest score for every aspect might be possible when one has all the means (money, space, social spirit, perfect neighbours, etc.) in abundance. In order to achieve one best condition, often other conditions have to be compromised.

Table 5.2: DCBA Sustainable Housing in Indonesia (continued)

ASPECTS	D COMMON USAGE	C SLIGHTLY IMPROVED	B SUBSTANTIALLY IMPROVED	A IDEAL SITUATION
1 ENERGY	No sustainable energy	Saving energy	Smart usage	Only sustainable energy
1.1 Energy Sources	Conventional energy sources (i.e. state-owned electricity grids and Liquid Petroleum Gas/ LPG)	Also use alternative energy sources	Use only alternative energy sources (i.e. solar energy for generating electricity, heating water, cooking, etc.)	Only use alternative energy sources and generate own energy from direct resources
1.2 Cooling	No effort to create cool indoor condition	Try to cool the interior by using conventional air conditioners that release substances which are harmful for the ozone layer	Try to cool the interior by using energy-efficient, eco-friendly air conditioner	Cool the interior by providing adequate ventilation that allows air flow – no air conditioning (involvement of an architect is necessary)
1.2 Lighting	Use conventional light bulbs; need most lights on both day and night	Use energy-saving light bulbs	Only use natural light in the day time; efficient use of lights at night	Use natural light in the day time and solar-powered lights in the night time
2 MATERIALS	Investment-based choice (cheapest & easiest to acquire)	Minimizing use	Local and renewable materials	Technologically & environmentally advanced materials
2.1 Foundation	Solid concrete foundation	Concrete blocks, which are more practical and use less resources compared to concrete	River stones, requiring even less concrete	Compressed earth blocks or timber for a stage house
2.2 Frame	Concrete or steel	Reduce the amount of concrete used and use of industrial timber	Use eco-labelled timber	Use local timber from forests that provide re-planting
2.3 Walls	Use concrete blocks	Use red bricks or industrially produced board with formaldedhyde glue	Use eco-labelled wooden or bamboo boards	Use sustainable and organic materials such as woven bamboo, coconut fiber and clay composite

Table 5.2: DCBA Sustainable Housing in Indonesia (continued)

ASPECTS	D COMMON USAGE	C SLIGHTLY IMPROVED	B SUBSTANTIALLY IMPROVED	A IDEAL SITUATION
2.4 Roof	Use corrugated asbestos sheet or corrugated iron/zinc sheet	Use ferrocement or concrete roof tiles	Use ceramic tiles	Use locally-made ceramic roof tiles, high recycled content clay or concrete roof tiles
2.5 Resources	Conventional commercial building materials from common suppliers	Alternative, locally-grown or produced building materials from local suppliers	Eco-labelled building materials from environmentally-concious suppliers (i.e. coconut fiber, coconut wood, bamboo chips/ composite)	Self-grown and self-produced building materials (i.e. local bamboo plantation)
3 WATER	Direct disposal system	Water-saving use	Efficient water use	Self-supplying system
3.1 Resource	Conventional (tap water) state-owned water company or drilling own well	Add collected rain-water for household purposes other than drinking/cooking	Add collected and purified (soil/ rain) water	Own water well, added by purified (soil/ rain) water
3.2 Waste water	- Throw waste water directly to sewers through water draining pipes - Let rain-water directly falls into sewers through drainage pipes	Directly re-using grey water (e.g. for watering plants/ gardening, washing bikes/cars).	Filtering grey water for household purposes, other than drinking/ cooking	Eliminating waste water by cutting out use (i.e. dry toilet)
3.3 Drinking water	No or difficult access to drinking water	- Moderate access to drinking water (i.e. communal pump) - Conventional water pipes and taps	Easy access to drinking water (household pump)	Also harvest and purify rain-water and soil water up to drinking quality
4 INDOOR ENVIRONMENT	No attention to indoor comfort/ health	Fulfilling the healthy house (minimum) standard	Attention to indoor health	Indoor health as a priority
4.1 Space	Less than minimum standard size (9 m^2 per person)	Fulfilling minimum standard size.(a moderate size house with fixed interior)	Flexible room arrangement (a moderate size house with multi-purpose rooms)	Separate rooms for different activities (a big house with one room for each activity)

Table 5.2: DCBA Sustainable Housing in Indonesia (continued)

ASPECTS	D COMMON USAGE	C SLIGHTLY IMPROVED	B SUBSTANTIALLY IMPROVED	A IDEAL SITUATION
4.2 Air & noise pollution	No specific efforts against air & noise pollutions	Minimize use of household appliances that cause air & noise pollutions (temporary solution)	Enough ventilation to circulate the air against indoor pollution, especially in the kitchen area (permanent solution)	Provide a separate room for noisy and air-polluting activities and using building materials that absorb noise (permanent solution)
4.3 Cleaning agents	Use commercial, chemical cleaning agents	- Minimize the use of commercial cleaning agents - Use natural alternatives whenever possible, such as using lavender instead of insecticides to repel mosquitos	Use only natural, bio-degradable cleaning agents	Self-produce and use natural cleaning agents
4.4 Household Waste	- Directly dispose used packages/ products - Mix all kinds of waste in a bin	- Re-use packages/ products - Separate bio-waste from the rest of the garbage	- Re-use and recylcle disposables for personal/household use - Separate household waste more precisely (bio-waste, paper, plastic, glass, etc.)	Also make income out of re-used and recycled household waste
5 SURROUNDING ENVIRONMENT	No attention to infrastructure/ spontaneous settlement	Standard infrastructure	Improved (partial attention to) infrastructure	Fully planned infrasructure
5.1 Garbage disposal	- Conventional garbage container (for mixed waste) for each or a group of household in the form of a hole in the ground, a drum or a garbage container. - To be collected by the municipality	- Separated containers for different types of garbage (bio-waste, paper, plastic, glass and chemical waste) - To be collected by the municipality	- Separated containers for different types of garbage. - Partly to be collected by the municipality; partly to be self-processed by each or a group of household	Self-process all types of waste: - Recycle bio-waste into compost/ fertilizer - Recycle paper waste into self-made paper products - Reuse glass and plastic waste or submit them to a recycling centre - Dispose chemical waste to a special disposal counter

Table 5.2: DCBA Sustainable Housing in Indonesia (continued)

ASPECTS	D COMMON USAGE	C SLIGHTLY IMPROVED	B SUBSTANTIALLY IMPROVED	A IDEAL SITUATION
5.2 Facilities	No access to water and electricity grids	Water and electricity facilites are provided after the housing is ready	Water and electricity facilities are already integrated duirng the building process	- Generating own electricity - Applying own water cycle/ systems (resource, use, recycle, disposal)
5.3 Building expansion	No planning/space for house expansion	Providing specific space for house expansion	Providing possibilities for house expansion (to grow either horizontally or vertically)	Provide high flexibility for house expansion
5.4 Public space	Lack of or minimum-sized, multi-purpose public space	Minimum-sized public space for basic needs (i.e. passage)	Multi-functional public space also for secondary needs (i.e. playground/ leisure, greeneries)	Enough public space for various purposes, which can accommodate all inhabitants' demands: leisure, gardening/food & herbs, greeneries/ clean & fresh air
5.5 Public facilities & services	Lack of basic level of public facilities and services	Primary public facilities and services are available	Primary public facilities and services are easily accessible	All public facilities and services are accessible, within walking distance
6 ECONOMIC	Lack of or no income	Ordinary neighbourhood	Make extra income	Production unit
6.1 Building finance	Conventional mortgage; ordinary interest system with a bank	- Partially financially self-supportive - Partially self-built (with gotong royong system)	Special loans/soft credit for housing with a housing co-operation	Having the right amount of money to purchase a new house
6.2 Money-generating household	Ordinary housing Energy-consumptive	- Reduce energy consumption - Use energy-saving home appliances	- Effective energy use (i.e. a control panel for energy and water consumption) - Partially energy-productive (i.e. solar water heater)	- Money-generating environment (housing as a production unit) - Energy-productive (i.e. solar electricity generator)
6.3 Certifications	A time-consuming, expensive and complicated process to acquire certificates	A time-consuming and complicated process to acquire certificates, within reasonable expenses	A complicated process to acquire certificates, within reasonable expenses and time span	A fast, practical process without complications in acquiring complete and valid certificates

Table 5.2: DCBA Sustainable Housing in Indonesia (continued)

ASPECTS	D COMMON USAGE	C SLIGHTLY IMPROVED	B SUBSTANTIALLY IMPROVED	A IDEAL SITUATION
7 SOCIAL-CULTURAL	No or lack of interactions among the inhabitants	Ordinary relationships among the inhabitants	Several communal activities exist	Solid co-operations in forms of communal projects and activities
7.1 Neighbourhood relationships	- Moderate; individual lifestyle - No further contact than knowing neighbours' names	Social interactions exist under special circumstances (i.e. birth, death, wedding); semi-individual lifestyle	Also make social contacts under casual circumstances (i.e. social gathering, nightwatch); communal lifestyle	- Constant social contacts - Total involvement from the majority of the residences
7.2 Neighbourhood activities (from D to A: requires more commitment and active participation from residences and a more complicated management)	- No communal activities - Communal needs (i.e. garbage collecting and neighbourhood patrol) are taken care of by a committee without direct involvement (other than obligatory fee) from residences	Neighbourhood activities: nighwatch (*ronda*), gathering (*arisan*), periodic cleaning (*kerja bakti*)	More neighbourhood collaborations, possibly profit-oriented i.e. co-operation (*koperasi*), a communal garbage processor and recycling centre, a neighbourhood kiosk	- Initiating, managing and conducting more complicated communal activities and facilities - Have a positive influence on neighbouring housing/villages
7.3 *Gotong Royong* (communal activities)	No *Gotong Royong* activities	*Gotong Royong* activities only when an emergency occurs	Occasional *Gotong Royong* activities	Routine *Gotong Royong* activities
7.4 Spill-over Effects	Lack of discipline of inhabitants in a neighbourhood has negative effect on its neighbouring areas (e.g. throwing garbage into sewers)	Domestic activities have no effect on neighbouring areas	Domestic activities have positive effects to neighbouring areas	Domestic activities have positive effects and are exemplary for neighbouring areas
7.5 Initiators	There is no person in the community who leads, motivates and initiates neighbourhood activities	There is a group of people in the community who motivates and initiates neighbourhood activities	The initiators of a community succeeded in encouraging a majority of their fellow inhabitants to participate in the (local) neighbourhood activities	The initiators are capable of giving trainings & workshops to their fellow inhabitants and people from other areas as well, who will become their apprentices

Table 5.3: Scores of Existing Examples According to DCBA Guideline

ASPECTS	HEALTHY HOUSING	*KAMPUNG* IMPROVEMENT PROJECT (KIP)	PPLH ECO-HOUSE	ITS ECO-HOUSE	BANJARSARI VILLAGE
ENERGY	Encouraging the use of natural lighting. B	Improvement in electricity access C	Natural lighting in the daytime, light bulbs in the night, no air conditioner B	Using passive solar design strategy that minimize the use of energy generating devices B	Not exceptionally different from other *kampung*s in Jakarta D
MATERIALS	Recommending materials of housing components, mostly bamboo and wood planks B	Houses are upgraded by 'permanent' or high quality materials (brick/cement walls, tile/terazzo and cement floors, and tile and zinc roofs) C	Local resources A	- Local materials, roof of coconut fiber (heat insulator), concrete floor as a cooling system - Several parts of the Eco-house are left unfinished, or made knock down, for the purpose of observation and research - The house is still used for experiment and research activities B	Not exceptionally different from other *kampung*s in Jakarta D
WATER	Assigning each house to provide one (shallow) well as the main water resource and a sewer for waste water; also sewers for in the yard and at road sides C	Wider access to clean and safe water and better drainage (hence less frequent flooding) C	Taken directly from a spring, has drinking quality, recycled in a simple water insulator B	From a spring beneath the building, recycled and reused; water installation inside each floor to cool the building B	Not exceptionally different from other *kampung*s in Jakarta D
INDOOR ENVIRONMENT	- Encouraging adequate ventilation and regular maintenance of house components - Assigning each house to provide: separate rooms according to each function, minimum space width (9 m^2/person) and minimum ventilation surface width (1 m^2/person) C	Residents are familiar with Healthy House standards B	No insect repellent (use nets), natural cleaning agents, no noise pollution (due to location) A	- Comfortable indoor thermal conditions - Disadvantages: hard wind flows, insect/mosquito attacks and high security risks B	Healthy House concept B

Table 5.3: Scores of Existing Examples According to DCBA Guideline (continued)

ASPECTS	HEALTHY HOUSING	*KAMPUNG* IMPROVEMENT PROJECT (KIP)	PPLH ECO-HOUSE	ITS ECO-HOUSE	BANJARSARI VILLAGE
SURRONDING ENVIRONMENT	Assigning each house to provide a garbage disposal site and to maintain the surrounding environment C	- Improved facilities: housing, footpaths, lighting and education and health facilities - An important outcome was the spillover effect: the KIP experience served as a prototype for investment and improvement in other areas B	Built in harmony with the landscape; some were built surrounded by artificial ponds to prevent insects from entering the building through land B	- ITS Eco-house stands among university buildings, surrounded by an open space - Functioning more as a lab rather than a residence, it can only be assumed that, in a dense urban scenario, ITS Eco-house has a standard infrastructure C	Minimum of 20 plants per household, monthly cleaning, including sewers and planting trees B
ECONOMIC	Healthy Housing guideline does not specifically mention financial arrangements D	KIP improved the quality of domestic living in Indonesian urban areas at a low cost of investment B	PPLH should support itself financially C	Initiated and funded by the Japanese government, maintained by the host institution, ITS C	Activity of handling paper and biowaste is adding to the income, a 'green kiosk' that sells recycled products and bags of compost and fertilizer; Banjarsari becomes a production-unit village A
SOCIAL-CULTURAL	Stimulating harmonic living among neighbours C	Inadequate operation & maintenance: garbage problems (dumped into sewage and drainage) D	Fits well with the neighboring villages, whose people can make extra income by working for/with PPLH B	- The design emphasizes the needs and lifestyles of regional communities; however, the application of a similar design in a public housing project has proven to be inadequate in this respect C	- Exceptionally solid relationship that supports communal projects - Banjarsari has a very dedicated leader/motivator A

Table 5.4 a: Healthy Housing campaign (HH)

	D	C	B	A
Energy				
Materials				
Water				
Indoor environment				
Surrounding environment				
Economic				
Social-Cultural				

Table 5.4 b: Kampung Improvement Program (KIP)

	D	C	B	A
Energy				
Materials				
Water				
Indoor environment				
Surrounding environment				
Economic				
Social-Cultural				

Table 5.4 c: PPLH Resort

	D	C	B	A
Energy				
Materials				
Water				
Indoor environment				
Surrounding environment				
Economic				
Social-Cultural				

Table 5.4 d: ITS Eco-House

	D	C	B	A
Energy				
Materials				
Water				
Indoor environment				
Surrounding environment				
Economic				
Social-Cultural				

Table 5.5 e: Banjarsari Village

	D	C	B	A
Energy				
Materials				
Water				
Indoor environment				
Surrounding environment				
Economic				
Social-Cultural				

Table 5.5: Overall scores for all examples

VARIABLES	CASES	D	C	B	A
Energy	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Materials	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Water	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Indoor Environment	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Surrounding Environment	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Economic	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				
Social Cultural	HH				
	KIP				
	PPLH				
	ITS				
	Banjarsari				

RECOMMENDATIONS IN ORDER TO IMPROVE THE PERFORMANCE OF THE GUIDELINE

- Further testing with experts to improve the performance of the guideline
- Test the guideline in a real situation.
- The DCBA for sustainable housing in Indonesia has never been tried in a real situation. It is assumed that representatives of inhabitants can propose the results of the discussion sessions using the DCBA guideline to the developers and investors so everyone's needs, wishes and demands can be accommodated. It is proven to be easy to understand. However, improvements still need to be made by presenting simpler yet sharper illustrations and have the booklet tested by experts of various fields relevant to housing development projects.
- The guideline can also be a useful decision making tool between inhabitants, developers and architects to solve problems together. The inhabitants use common language to present their ideas and requirements; the technicians (engineers, architects, etc.) should be able to translate these ideas into physical and financial calculations. A proposal: make a detailed (technical) DCBA table that responds to each column of the 'daily language' DCBA, so technicians can refer to this one.
- Perhaps there needs to be a much simpler version for emergency situations (concerning urgent settlements for disaster areas).

The usability of this booklet was evaluated in two usability sessions with Indonesian students, who acted as inhabitants of a housing project. This illustrated booklet has proven to gain interest and discussion among the students and was found quite comprehensive (see Appendix I). However, improvements are necessary if practiced in a real situation, such as the use of simpler terms and detailed variables (i.e. population numbers, budget, etc.).

During the completion of this thesis, a cartoon book for lay people entitled *Rumah Impian Loen* (= My Dream House) was published by the Architecture Clinic (ArCli), which is a joint initiative of PT Holcim Indonesia Tbk, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and Ikatan Arsitek Indonesia (IAI, or the Indonesian Architect Association), with support from the United Nations Development Program (UNDP) – UN Habitat.[3] This comics-booklet was created so:

- all age groups and lay people can acquire a better understanding of the right building materials and building techniques
- building/house owners can build their own house
- increase people's awareness (community monitoring) in Aceh

The booklet explains, among others, that the *bataton* is a sustainable building material for Aceh, since the production resources are available locally, and as an earthquake-proof material, if the building is designed properly. Beside the *bataton*, this booklet also introduces the *arcli block*, a paving block, the concrete earth block, and the micro concrete roof. However, the discussion in this booklet is limited to building material production, building techniques, and touches only briefly upon land ownership and building certificates. It does not mention the aspects of housing finance, traditional (Acehnese) housing culture or social structure that might influence decisions in local housing projects. Aside from the lack of context (in the relation to the sustainable building aspects), this cartoon book is an excellent communication tool and knowledge dissemination tool, as proposed in the first point of the Recommendations (Chapter 8).

About the characteristics of different actors in reaching the highest scores: specific to the analyzed examples, the DCBA scores for each actor show the tendency of their main potentials and capacities:

- *Government programs (HH, KIP)*: Score high on infrastructure and supply to electricity and water, because they are capable of providing the means (policy, state owned grids, etc.). Government projects tend to improve infrastructures (electricity, water) and building.

- *NGO resort (PPLH)*: Scores high on indoor and surrounding environment because they have the advantage of space or location, and the buildings are not tied to the city regulations. They also have the advantage of design and material choice, for being in their own location makes security more controllable. An NGO whose concerns are environment quality is more practical, but they have the advantage of location.
- Academic institution (ITS): Scores high on technicalities, for they have the advantage of emphasizing their choice of research priority. In the case of ITS, the indoor thermal comfort. Other aspects that are not relevant to the research can only be estimated. The academic institution that is presented here focus on indoor thermal comfort and is still conducting the research.
- Self-initiated activity (Banjarsari): Scores high on social-cultural aspects because, already by having this self-initiation, they have proven to be a working community, who is willing to develop itself towards sustainable lifestyle. Their success proved that they have charismatic leaders who encourage and manage to mobilize the people regularly. Self-initiated projects tend to strengthen the neighbourhood and social relationships.

RECOMMENDATIONS

- These conclusions, however, need to be tested further with more examples to reach validity.
- Actors, both individuals and institutions who would like to go to this direction can follow these examples.
- The key is just to use most of each potentialities in the most relevant or possible condition. Improving strategies.
- Each potential is used optimally to reach a sustainable condition in particular kinds of fields. This comparison with DCBA can function as a guideline also for building projects in conditions similar to these examples. The DCBA table is a simple and quick way that helps determine the scores and guide audience to the best quality of each example.

Notes

1. *See chapter 3.3 which provides a lengthy argument about the addition of economic and social-cultural aspects to the sustainable building aspects.*
2. *However, there is one known research concerning the impact of social housing on the health of its dwellers: 'Crowding and health in low-income settlement', a collaborative research among Urban Health Study Group of Atmajaya University (Jakarta) and COWIconsult (Denmark), supported by UNCHS/Habitat (Nairobi), 1993-1994.*
3. *See p.14 about common housing problems in Indonesia*
4. *Ranging from US$ 118 per person in Jakarta to US$ 23 in smaller cities, 1993 US dollars (World Bank Group Evaluation Report number 14747, 29 June 1995).*
5. *Indonesian term: gotong-royong (see Chapter 3 for an elaborate description about gotong royong).*
6. *1.300.000 IDR equals to about 97 EUR (rate in July 2006)*
7. *Common people may have only limited or no expertise and knowledge of the technical or engineering aspect of a housing project; therefore, their input in these aspects may also be limited. However, future inhabitants or their representatives must have access to updated information about the housing project during the building process and see that their requirements are accommodated properly.*
8. *There are not enough sanctions against those who have neglected the provision of basic services for the poor and have not been able to support the achievement of efficiency and environmental development (Tjiptoherijanto, 1996).*
9. *Available at http://www.worldenergy.org/wec-geis/publications/reports/ser/solar/solar.asp*

Some examples of publications with an approach similar to the DCBA booklet: illustrated publications containing information and guidelines about building projects.

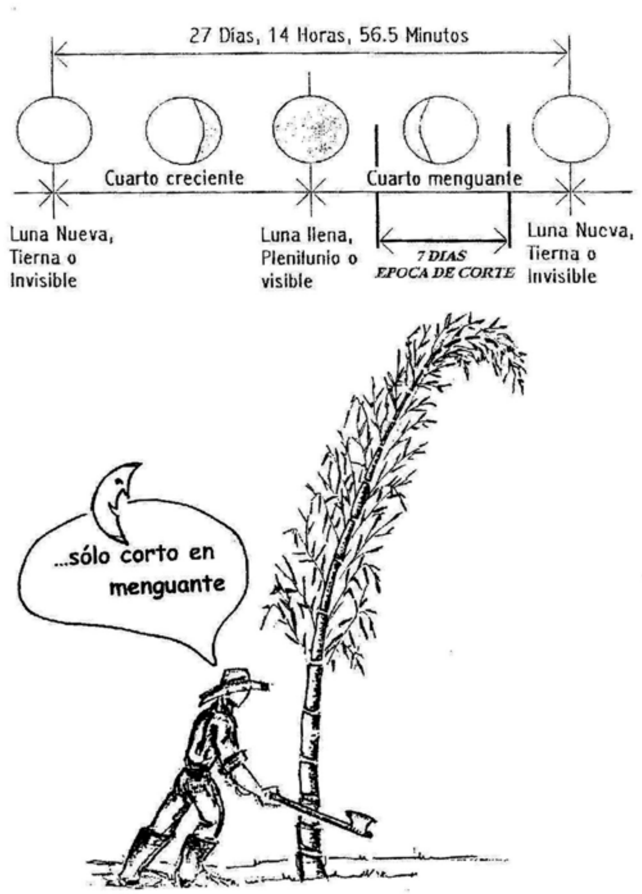


Fig. 5.7: The Spanish text says, 'only cut in the waning quarter' (of the moon). This picture is an example of an illustrated manual for bamboo as a housing material from Latin America (Moran, 2002), which functions as a communication tool for local bamboo farmers and workers.

Fig.5.8: An illustration from Rumah Impian Loen*: a scene on page 33 that shows a demonstration of how strong* bataton *is (bataton* = bata beton, *or concrete brick).* Upper text: '*Correct. A safe building material means that it fulfills technical standards, the* Standar Nasional Indonesia *(SNI). For instance, this* bataton. *Look! Even though I drop it, it does not crack or break easily.'* Lower text: '*Ahh.. you startled me there, Mr. Indra. So this* bataton *is really strong, isn't it?'*

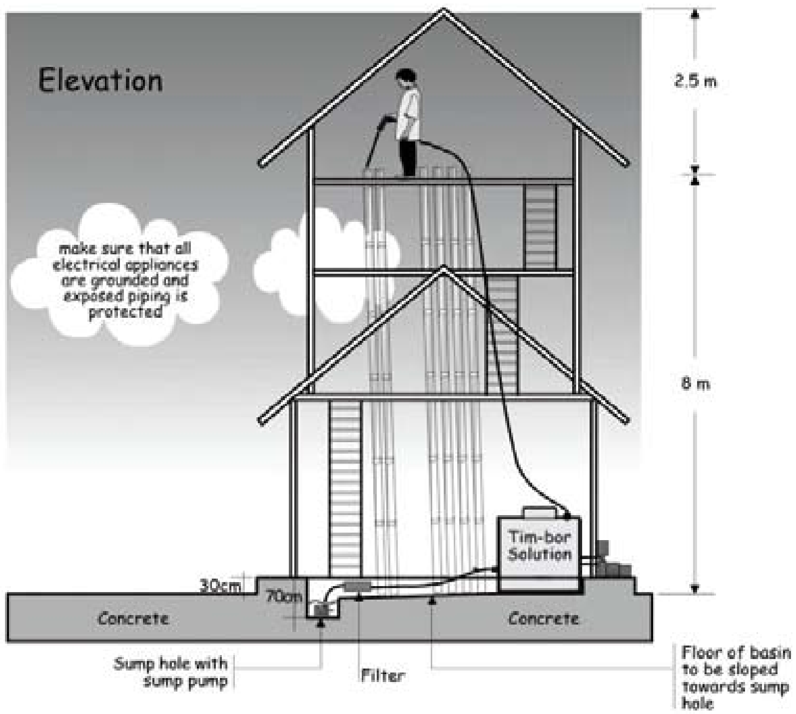


Fig.5.9: An image from Vertical Soak Diffusion for Bamboo Preservation*, a fully-illustrated booklet published by the Environmental Bamboo Foundation (2003). The booklet mentions that the vertical soak diffusion (VSD) method of preserving bamboo works well with small-plantation situations and community development work in rural villages.*

6. FOCUS ON BAMBOO AS AN ALTERNATIVE BUILDING MATERIAL

This chapter discusses a more practical issue: the example of bamboo is chosen to see how it fits into the theories, set of requirements and guideline that were proposed in the previous chapters. The first part discusses bamboo as a building material in Indonesia, the most advanced treatment of bamboo and its influence on small- and medium-sized enterprises (SME) in Indonesia. The second part discusses the sustainability of bamboo as a building material. The chapter ends with an analysis of bamboo's feasibility as a sustainable building material.

6.1 Bamboo as a Building Material in Indonesia

Despite the fact that bamboo has been used as a building material for centuries in Indonesia, the development of bamboo's performance was held back, due to the generally unfavorable perception of bamboo. This inferior social status of bamboo occurs mostly in countries with a colonial history; while in developing countries without colonial experience it is much less a problem.[1] In addition, there are several other factors that discourage bamboo development: the lack of knowledge and technology dissemination in bamboo treatment, inadequate information about bamboo (especially aimed at the business sector), limited Indonesian bamboo research activities (until the establishment of the Indonesian Bamboo Researcher Association in 1995) and capital constraints (State Ministry of Environment, 1998). However, in recent times, bamboo has been receiving more attention, since advanced technology of bamboo treatment, involvement of expertise in bamboo building technology and modern design application to bamboo products have given bamboo new appearances and performances. This sub-chapter discusses the development of bamboo material research and application, and its influence on small- and medium-sized enterprises in Indonesia.

BAMBOO AS WOOD SUBSTITUTE

The whole process of housing development has caused a huge impact on our natural surroundings and environment. The supply of building materials, to mention one issue, has put an indirect pressure on the Indonesian tropical forest.[2] Tropical hard- and softwoods,[3] as main building materials, have been used in large quantities, thus exploitation occurred in tropical forests, but unfortunately without proper control and management. Today, the situation of Indonesia's tropical forests is approaching a crisis (Soemarwoto, 1991), in that the current and expected rate of their exploitation exceeds their possible replacement.[4] Therefore alternative materials to be used as wood substitutes are being sought. Bamboo, a fast-generating plant with constructional properties, can act as one.

BAMBOO: A COMPETENT BUILDING MATERIAL

Bamboo has been known for centuries as a reliable construction material. It has been used for houses, bridges, scaffoldings, towers and many other structures. However, it has been long forgotten in the recent architecture of modern houses. This situation is caused by the stigma of bamboo as 'poor man's timber' (Janssen, 1997), which discourages its usage. Bamboo is considered inferior both in performance and appearance, compared to other building materials that are available at present.

This is an unfortunate condition, because bamboo is actually a competent building material. Its cell structures and technical properties resemble wood, yet it is superior in both strength and elasticity when compared to wood and steel. The Modulus of Rupture and Elasticity of bamboo have been

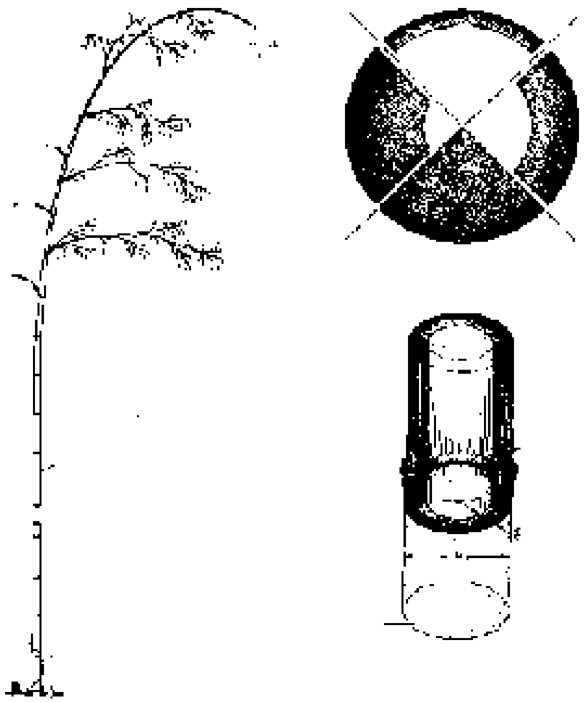


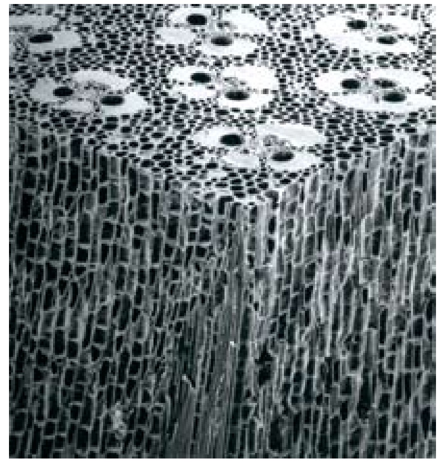
Fig. 6.1: Cross-section of bamboo that shows different thicknesses of a bamboo tree. The growing points (rings on a bamboo pole) are the strongest points of a bamboo pole (Dunkelberg, 1985).

proven to be equal to that of hardwood. After its first three years of growth, bamboo's skin contains an abundant proportion of silicon acid that hardens the surface and protects it from termites, chemical substances and mechanical forces (Dunkelberg, 1985). The physical and mechanical properties of bamboo, along with its rapid regeneration, make bamboo a potential material to supplement the valuable, endangered tropical woods.

For traditional housing purposes, bamboo is processed into various forms of production materials, such as poles, rods, splits, strips and mats (woven strips), and then fastened with lashing and other bamboo carpentry techniques to form structures, walls, ceilings and ground coverings.[5] Waterson (1997, p. 85) notes:

> *For temporary buildings[6], or where wood is expensive or in short supply, bamboo provides a highly versatile and readily available building material. Larger stems provide framing members; split and flattened, they can be used as flooring, or woven to make wall screens. Shorter lengths sliced in half make interlocking tiles, such as are used to roof the family origin-houses of the Toraja. A well-made bamboo roof of this type will last for forty years or so – much longer than its now popular substitute, zinc.*

This traditional technology is no longer appropriate when applied to an urban setting, or a growing rural area, where different needs and lifestyles occur. In the rural areas, once enough money is collected, bamboo houses' occupants upgrade their houses by adding conventional building materials such as bricks and cement. This effort requires both traditional skills in bamboo treatment and (adapted) contemporary building methods.



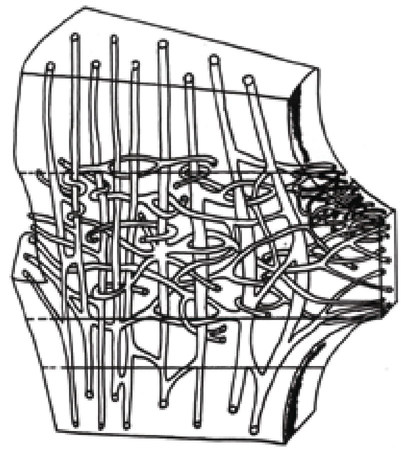


Fig. 6.2: Three-dimensional view of culm tissue of Oxytenanthera abyssinica *with vascular bundles embedded in ground parenchyma (Liese, 2003). Fig. 6.3: Illustration of vascular connection within nodal regions (Liese, 2003)*

Another effort to improve the performance of bamboo is through preservation techniques, mainly to prevent cut bamboo from cracking/splitting and weathering (damage by UV and visible light radiation, which causes photo-degradation), and to protect bamboo from fungi and insects (beetles, termites and marine borers), which are still being developed to increase bamboo's durability.

Traditional methods in preserving bamboo, due to their low cost, are still widely implemented:[7]

- clump curing: bamboo culms are cut at the base and left in the clump with their crown leaning against neighbouring ones for a few days
- water storage: soaking freshly cut bamboo culms in running or stagnant water or mud for 1-3 months
- boiling: boiling green clumps or slivers (for weaving) for 30-60 minutes
- lime washing or white washing: painting bamboo culms and mats for houses with slaked lime ($Ca(OH)_2$), mainly for ornamental effect
- plastering (of bamboo mats): using mud, clay or sand mixed with lime, cement, or cow-dung for stability
- traditional smoking: storing fresh bamboo culms inside the house above a fireplace (traditional Japanese method).
- heat treatment: thermal treatment above 150°C

Constructional methods are also applied to avoid damage, by keeping the bamboo components dry below the fiber saturation point, so that no fungal attack can occur. A centuries-old tradition for the proper construction use of bamboo without chemical treatment exists; commonly by placing bamboo or walls on either stones, pre-formed concrete footings or durable/pressure treated wood blocks, instead of putting them directly onto the ground. The culm should be cut just below a node for better stability. The culm is not to be placed directly into concrete as it may shrink, leading to an interspace where moisture and humidity can facilitate fungal attack.

These traditional methods can be effective against fungal and partly against beetle attack but hardly against dry-wood termites. Bamboo construction should regularly be inspected for a good management of termite problems. The INBAR Technical Reports No. 15 by Jayanetti and Follett (1998),

Fig. 6.4: Bamboo poles being treated with the Boucherie preservation technique

No. 19 by Gutiérrez (2000) and No. 20 by Janssen (2000) and others (i.e. Cuzack 1999) illustrate the manifold possibilities for bamboo protection by design and construction (Liese, 2003). The methods of bamboo preservation are improved by incorporating chemical substances and using special equipment, i.e. the Boucherie treatment (see Fig. 6.4 and Fig. 6.5).[8]

BAMBOO BOARDS

Another technique designed to improve bamboo's performance as a building material has resulted in various kinds of bamboo boards. Traditionally, bamboo in the form of sheets is produced by weaving bamboo ribbons into mats without any adhesive substance, which could serve for example as parts of a hut. While the modern attempt to make bamboo into thick, firm sheets, in principle calls for having the bamboo in a flat shape (splits or woven mats, produced by machine or manually, depend on local human resources and skills) and adding an adhesive substance. The bamboo splits or layers are dipped into an adhesive substance (see the following paragraph about adhesive substances) and are stacked one on top of another, before being inserted into a pressing machine. The whole process is similar to producing plywood or composite board.

The main types of resin used as adhesives in composite fiber manufactures are: *Diphenylmethane diisocyanate* (MDI), *Urea-Formaldehyde* (UF), *Phenol-Formaldehyde* (PF) and *Polyurethane*. An emerging class of 'bio-based' adhesives derived from plant materials (primarily soy) are actually much safer substances, however, none are yet available on a competitive commercial basis.

- *MDI* is a newer resin (compared with UF and PF) that has gained market share partly in response to public concern over formaldehyde emissions. MDI, which is used in most of the strawboard plants, is a liquid binder based on 100% active ingredients. Being a very efficient resin – due to the fact that it makes a molecular and not just an adhesive bond – it also has its drawback in that it can stick firmly to metal or the human body. It does not release off-gas after usage, however,

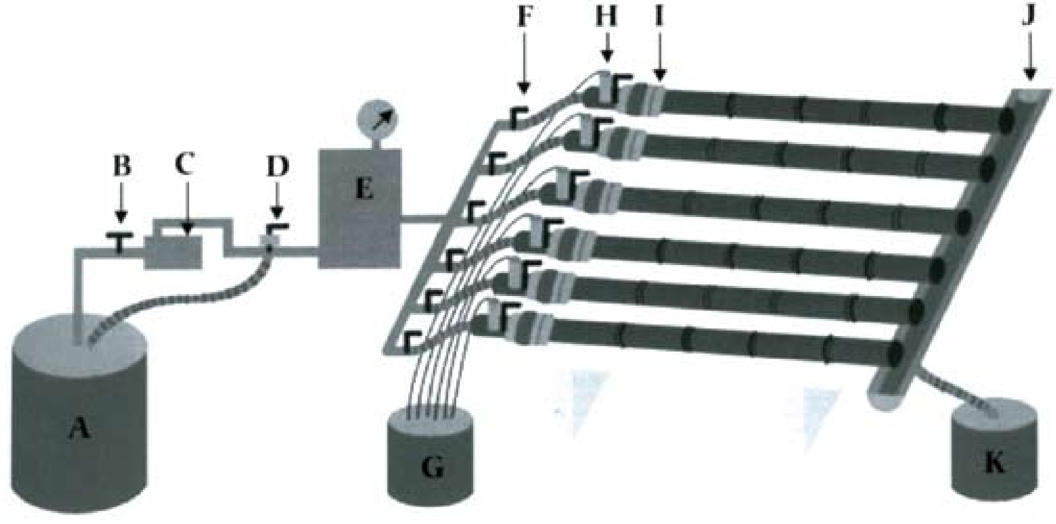


Fig. 6.5: Sketch of the sap-replacement method for bamboo, modified from the Environmental Bamboo Foundation/EBF (1999). Treatment Equipment (Liese, 2003, pp.132-133)

A. Closed container for the treatment solution to take a pressure of 1.5 bar; B. Tap for regulating the input of the solution; C. Water pump machine or air compressor; D. Tap for regulating the output of the solution; E. Pressure regulation tank; F. (1-6) Taps for regulating the solution flow to the nozzles of the manifold outlet; G. Collection tank for surplus preservative; H. Tap for bleeding air from the nozzles before the solution enters; I. Nozzle with rubber sleeve and clamps to seal the pipe-culm joints; J. Collection of outflow; K. Bucket for solution. The tank must be able to stand the pressure applied. As the preservative may be corrosive, heavy-duty plastic should be used for all components.

during the production of the resin itself, workers must take great care, as it is highly volatile and has no odour. MDI tends to be more expensive than formaldehyde resins and it is shipped in liquid form; the cost of MDI has risen close to 15% over the past year.
- *Urea-Formaldehyde* (UF) is a colourless, pungent-smelling gas that can cause negative effects to sensitive people. Sensitivities can include watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels (above 0.1 parts per million). High concentrations may trigger attacks in people with asthma. According to the US Environmental Protection Agency (EPA), it has also been shown to cause cancer in animals and may cause cancer in humans.
- *Phenol-Formaldehyde* (PF) is a red/black-coloured resin used in pressed wood products such as softwood plywood and flake or oriented strand board for exterior construction. Although formaldehyde is present in both types of resins, pressed woods that contain PF resin generally emit formaldehyde at considerably lower rates than those containing UF resin.
- *Polyurethane* is used to produce rigid foams, flexible foams, sealants, coatings, elastomers and agrifiber binders. Applications for these products cover a wide range of end uses, including cushioning for furniture and bedding, carpet backing, automotive seating and instrument panels, office furniture, flooring, and insulation for appliances, sheathing and roofing.

The continuous progress from traditional to advanced technology still allows local people in rural areas to be involved in the various stages of the manufacture of bamboo as a building material. The

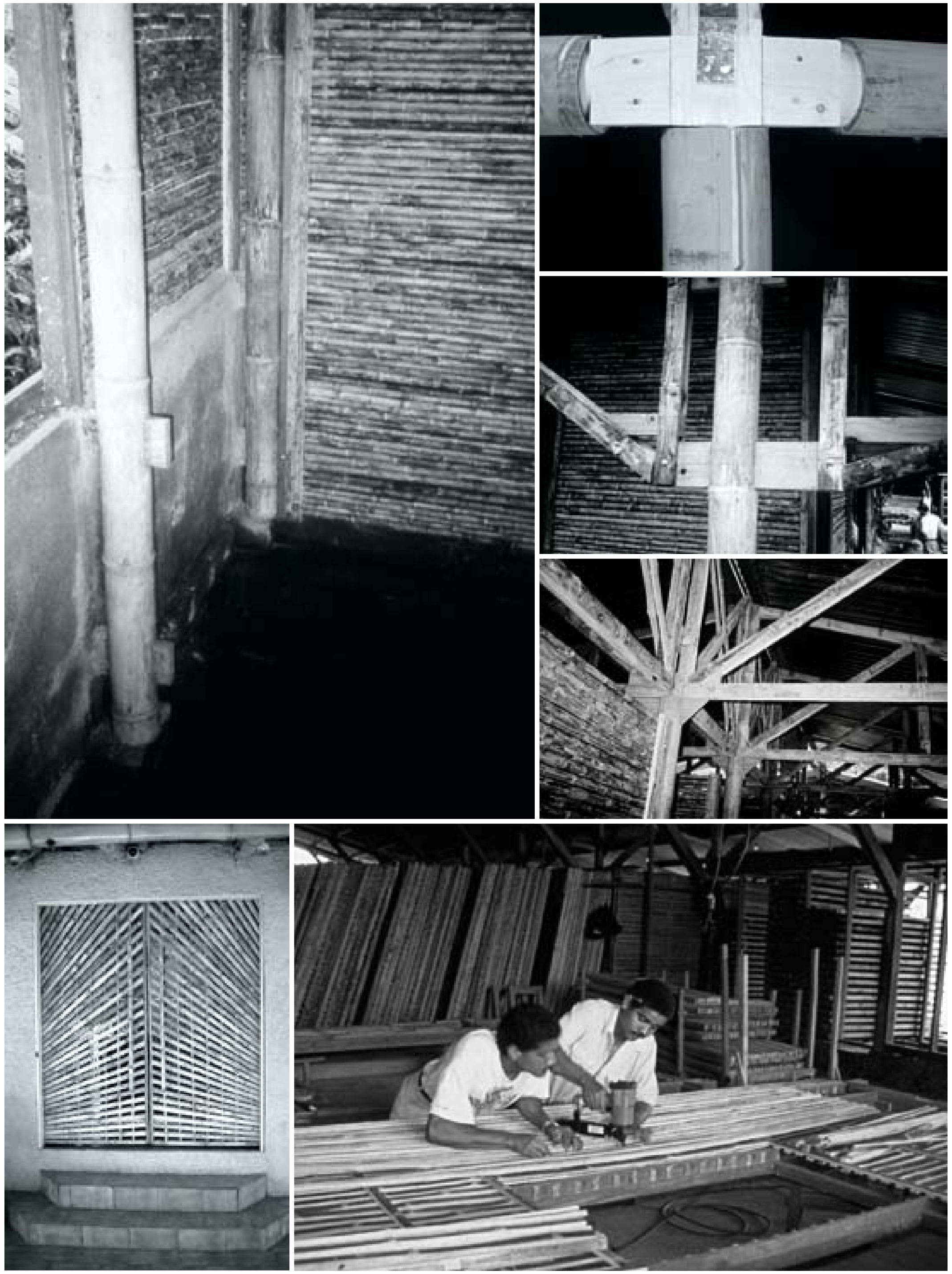


Fig.6.6: Details of timber joints for bamboo culms construction (Janssen, 2000, pp. 96) / Fig. 6.7a & b: Timber joints for split bamboo (Janssen, 2000, pp.110) / Fig. 6.8: Joints of bamboo culms and boards made of split bamboo (Janssen, 2000, pp.161) / Fig. 6.9: Door panels made of split bamboo (Janssen, 2000, pp.158) / Fig. 6.10: Labour-intensive fabrication of boards made of split bamboo (Janssen, 2000, pp.161).

Table 6.1: Hybrid Technology in Bamboo Industry. Many possible solutions fall within the category of hybrid technologies, but all solutions share a focus on labour intensive, modified household enterprise.

HYBRID TECHNOLOGY IN BAMBOO INDUSTRY			
	MODIFIED TRADITIONAL METHOD	COMBINATION OF TRADITIONAL AND ADVANCED METHODS	ADAPTIVE ADVANCED METHOD
PRODUCTION MATERIALS	Raw bamboo: culm, rod, strips, etc.	Raw bamboo: culm, rod, split, strips, etc., and pre-treated bamboo: boards, composites, etc.	Pre-treated bamboo: boards, composites, etc.
PRESERVATION METHOD	Traditional method	Traditional method, injecting preservative substances	
TOOLS	Simple household possessions, additional small machinery	Specialized tools, additional small machinery	
PROCESSING	Manual technique with machinery support		Manual processing of pre-treated production material
PRODUCT ASSEMBLING	Weaving technique, conventional manufacture assembling, adapted manual technique		Conventional manufacture assembling
OTHER MATERIALS AND SUBSTANCES	Adhesive substances, additional product elements		
FINISHING	Variable: natural, polishing, colouring, laminating		
PRODUCT GROUPS	Boards, building components, kitchenware, tableware, furniture, accessories, etc.		
DESIGN	Modified traditional products, new and improved design		
ENTERPRISE	Labour intensive, improved household enterprise, with co-operative organization of producers that are protected by government's policies		

modern technique of fitting pieces of timber into the end of a bamboo culm in the prefabrication of full culms housing (see Fig. 6.6), for example, can be implemented at the village level. Another example concerns split bamboo, which, traditionally produced, now can also be used in trusses and prefabricated wall panels (see Fig. 6.7a-b, Fig. 6.8 and Fig. 6.9). Traditionally-designed elements can still contribute to modern building (see Fig. 6.10).

USAGE OF BAMBOO BOARDS

As an industrial product, bamboo boards are preferred to bamboo culms, since technical problems related to the geometry of the culm can be avoided (van der Lugt et al., 2003). For the image of bamboo, the appearance and performance of bamboo boards provide new, positive insights, which can remove the stigma from bamboo. However, the most significant benefit of bamboo boards production is the range of choice of industry level. Levels of technology in bamboo products manufacture range from traditional (fully manual, labour intensive), advanced (additional substances and product elements, specialized machinery) to hybrid (modification or combination of both traditional and advanced), as shown in Table 6.1 (Larasati, 1999).

In this table, bamboo board is presented as one of the results of all three levels of technology, which means that bamboo boards can be produced within (a combination of) these levels, depending on the local resources and potentialities available. Consequently, bamboo boards come in various types, from plybamboo or compressed mats (woven mats as the main substance) and particle board (bamboo chips as the main substance) to high-quality bamboo boards with bamboo strips as the main substance. In the levels of *Modified traditional method* and *Combination of traditional and advanced method*, the ongoing involvement of the local people in the production of bamboo as a building material is valuable, because the traditional skills are still practiced (and are therefore preserved).

Establishment of a bamboo plantation for industrial purposes (e.g. as raw material supplier for a bamboo board production) is seen as advantageous to the surrounding natural environment, due to bamboo plants' ability to absorb and bind many pollutant gasses and substances in the air, soil and water. If planted on critical land, bamboo can prevent erosion, landslide and degradation of land quality (Billing & Gerger, 1990). However, it should be taken into account that the cultivated bamboo species should be able to adapt to the local conditions (or, even better, is indigenous to the area) and that the plantation does not disrupt other plantations or bio-diversity in the surrounding habitat.

Bamboo boards also have their drawbacks. As an industrial material, the environmental advantages of the bamboo culm are lost.[9] Compared to most wood-based alternatives, the environmental performance of the assessed bamboo board is slightly less favourable (van der Lugt et al., 2003). In China, where bamboo board has been manufactured for over ten years, urgent solutions are needed to solve the following problems: low production capacity, low utilization of bamboo and outdated technology and equipment (Yan, 1995). Due to transportation issues, or the distribution of bamboo boards, energy consumption and air emissions resulting from the transportation requirements of bringing the bamboo to the market should be taken into account, since bamboo for boards is generally grown and manufactured in China or Vietnam. Some green building rating systems or guidelines give preference to the use of materials that either originate or are manufactured locally, which is often defined as within a 500-mile radius from the project (CIWMB, 2003).

The performance of bamboo board is being investigated up to today, especially to overcome its downsides, such as testing its fire resistance and its durability in various outdoor weather circumstances, finding a totally non-toxic adhesive substance and reducing production costs (related to treatment and transportation).

CONCLUSIONS

- An indirect consequence of the present housing industry is the scarcity of tropical forests, since these forests are being exploited for their soft- and hardwoods, as building materials. Bamboo, which is classified as non-wood (it belongs to the grass family) with its constructional properties and fast regeneration, is a competent material to supplement wood. With contributions from technology, the appearance and performance of bamboo can be improved.

- Bamboo board is a new building material that still has a wide range of possibilities in its application. Bamboo board industries cover all levels of technology and industries, and provide a wide opportunity for SME's to integrate and co-operate with big-scale industries.

- Given the current situation in Indonesia, hybrid technology is the most suitable level for bamboo industry development. The goals of hybrid technology, appropriately applied, are to create an improved, functional product that will meet the needs of the users and to provide for local employment and economic development without social or environmental disruption.

WHAT IS THE DIFFERENCE BETWEEN A HARDWOOD AND A SOFTWOOD?

As it turns out, a hardwood is not necessarily a harder material (more dense) and a softwood is not necessarily a softer material (less dense). For example, balsa wood is one of the lightest, least dense woods there is, but is considered a hardwood.

The distinction between hardwood and softwood actually has to do with plant reproduction. All trees reproduce by producing seeds, but the seed structure varies. Hardwood trees are angiosperms, plants that produce seeds with some sort of covering. This might be a fruit, such as an apple; or a hard shell, such as an acorn.

Softwoods, on the other hand, are gymnosperms. These plants let seeds fall to the ground as is, with no covering. Pine trees, which grow seeds in hard cones, fall into this category. In conifers like pines, these seeds are released into the wind once they mature. This spreads the plant's seed over a wider area.

For the most part, angiosperm trees lose their leaves during cold weather (in non-tropical regions), while gymnosperm trees keep their leaves all year round. Therefore it's also accurate to say evergreens are softwood and deciduous trees are hardwood.

The hardwood/softwood terminology does make some sense. Evergreens do tend to be less dense than deciduous trees, and therefore easier to cut, while most hardwoods tend to be more dense, and therefore sturdier. But, as the classification of balsa wood demonstrates, there is no minimum weight requirement for hardwood.

- Re-socialization of bamboo as a building material might increase demands for bamboo, therefore increasing the need for properly managed plantations and cultivation, which can lead to empowerment of bamboo farms in bamboo's indigenous habitations.

RECOMMENDATIONS

- The modular coordination (*Koordinasi Modular*/KM) system is proposed as one of the means to apply an environment-oriented housing technology in Indonesia (Komarudin, 1997). The main purpose of the KM system is to set up uniform measurements of various building materials, components and elements, which is expected to increase production efficiency and to reduce waste of (left over) production materials.

- In the case of bamboo, a feasible application of the KM system is the production of bamboo panels in the same size that fit into most designs. Furthermore, flexible adjustment of the panels should be possible during the building process, in order to fulfillsome details of a house design that might not need fully applied modular elements.

- Further investigation of the practice of bamboo board production is necessary, in order to find out if the whole process is entirely sustainable. The input (natural resources and energy) and the output (waste, emissions and products) of the bamboo board lifecycle (from production, to usage, to disposal) should be compared to those of plywood production (as a product of the same functional unit as bamboo boards), along with an analysis of the economical aspects. The 14000 ISO series for bamboo as a building material should be used as a reference. Life Cycle Assessment (LCA) and Eco-Value Ratio (EVR) methods are recommended tools for the calculations needed.[10]

6.2 The Use of Bamboo as a Sustainable Building Material: Examples from Indonesia, Costa Rica, Ecuador and China

In the lands of bamboo's origin it is common to find bamboo housing, especially in rural areas. Although the housing varies a lot, there are similarities in the main principles of using bamboo: bamboo culms as pillars and frames, and bamboo mats or strips as walls. This type of housing is inexpensive, since the main material, bamboo, is available locally and the building process and maintenance technology are within the skills and capability of the local communities. Although, compared to contemporary housing it is considered inferior, bamboo housing has its advantages and is improving in performance and appearance. Aside from its low cost[11] and energy consumption,[12] its light weight and elasticity provide resistance to earthquake pressure.[13]

Following are examples of bamboo housing projects: Kali Code Village in Yogyakarta (Central Java, Indonesia), where a formerly illegal settlement became an award-winning site: the National Bamboo Project in Costa Rica, which emphasizes the use of bamboo as the main building material; the Hogar de Christo Housing Project in Ecuador, which provides housing for low-income people; and Promotion of Sustainable Buildings in China, which integrates the use of bamboo with a bioclimatic approach, with the purpose of minimizing ecological damage and use of energy. These examples give an illustration of the use of bamboo as a (sustainable) building material in an acknowledged success case in Indonesia and in countries which conditions are similar to those in Indonesia. The end of this part answers the third research question: *How sustainable is bamboo as a building material in Indonesia?*

KALI CODE VILLAGE, YOGYAKARTA, INDONESIA

Kali Code is one of the three rivers which runs through the heart of Yogyakarta, whose bank became a location of a densely built settlement, which can be seen from the bridge of a main city road (which is also a route from the airport to the city center) high above the river. With the argument that this view caused a negative impression of the city on the tourists, the municipality threatened this illegal settlement with eviction. But after every eviction, the inhabitants (of 30-40 families), who had no alternative, returned to this spot.

In 1983 an architect, Mangunwijaya (a former Catholic priest who was also a writer), came to the assistance of the residents by persuading the government to commence an upgrading project instead of demolition (Duivesteijn & van de Wal, 1994). He saw that this kind of settlement can only survive if the inhabitants confront their housing problem as a unity. He put as a priority the inhabitants' desires, as a single group, in determining the design of their own dwellings and in adjusting to changes during the process. Two community buildings, which were built first, became the center of the building activities for the rest of the village.

For this project, Mangunwijaya used bamboo, wood, roof tiles and occasionally concrete. The building techniques were simple; the design process required few drawings and no construction documents. The neighbourhood was almost entirely built by the residents themselves. As a finishing touch, a group of art students volunteered to paint decorative patterns on the walls of the houses, which gave the site a unique, colorful appearance.

The quest of Mangunwijaya resulted in an outstanding achievement not only in the form of a unique style of architecture and building process, but also in the fact that this project has succeeded in augmenting the self-respect of the inhabitants. The Kali Code project, which was completed within two years, won the Aga Khan Award in 1992 for architecture in Islamic countries and (ironically) has become a tourist attraction.

Fig. 6.11: A street among the houses of the village. Fig. 6.12: The village, seen from Code River. Fig. 6.13: A view from above the village

THE NATIONAL BAMBOO PROJECT, COSTA RICA (UNCHS-HABITAT, 1990, 1992)

The national bamboo project in Costa Rica is a remarkable effort to revive the use of a traditional material and technique to provide cost-effective housing. With financial and technical resources provided by the Government of Costa Rica, the Government of Netherlands, the *Banco Centroamericano de Integración Económica*, the United Nations Development Programme, the United Nations Centre for Human Settlements (Habitat) and the International Labour Organisation, the project focuses on the production of bamboo as a building material for housing, bamboo planting for afforestation, training in skills for bamboo construction and demonstration housing projects.

The first phase of the project (1988-1991) managed to bring construction costs of bamboo housing units well below the least expensive completed unit available on the market, making it the most attractive option for the majority of low-income families in the country. Large-scale cultivation and the establishment of small production units for building components in rural areas are expected to generate major employment opportunities as production expands. This will also reduce the use of wood for housing construction, limiting environmental degradation.

The excellent seismic-resistant qualities of bamboo structures were dramatically demonstrated in April 1991 when a powerful earthquake caused widespread damage to houses in Costa Rica, leaving the 30 units built by the project in the affected area undamaged (see Fig. 6.14).

Fig.6.14: A bamboo house that survived a 7.6 magnitude Richter scale earthquake in Costa Rica. The short poles in the foreground are remains of a timber house that could not endure the earthquake (Janssen, 2000).

The Government of the Netherlands provided emergency aid for reconstruction using bamboo at the end of the first phase (1991) and during the second phase (1992). In the second phase of the project, which started in January 1992, reforestation with bamboo was expected to allow the construction of 7000 houses per year after 1995. In 1996 this project became a foundation and changed it's name to *Funbambu*, a non-profit organization which is supported by several organizations such as the *Banco Centroamericano de Integracion Economia* (BCIE), HABITAT, *el Programa de Naciones Unidas para Desarrollo* (PNUD), and the governments of Costa Rica and the Netherlands.

This project, being a 'single product/single client company', had to come to an end in 1999. The single product was cheap housing; and the single client was the Costa Rican government through the social subsidy system. Had the project developed other products, such as houses for the middle-class, furniture or boards, they could have survived the change in government (which led to a change of policies) after elections (Quintans, 1998).

HOUSING PROJECT: VIVIENDAS HOGAR DE CHRISTO (VHC), ECUADOR

Viviendas del Hogar de Cristo (VHC) is a Christian NGO based in Guayaquil, which uses 300,000 bamboo culms annually for the construction of low-cost housing. VHC has been in existence for 30 years and has produced more than 60,000 houses. VHC has developed its own method of producing low cost housing from Guadua bamboo that can be constructed extremely rapidly and is very cheap.

The process of acquiring a house for a potential client takes about four to six weeks, from being informed about the house, being verified as an eligible client, until signing a contract and collecting the house from VHC (the client pays construction workers; however, in many cases neighbors or family members with experience do the construction).

The overall cost of the house is US$350 (although, since this document was written, the cost has risen to $450). The government subsidises this with an amount of US$144 (housing subsidy of US$4 per month for three years). The client has to cover 186US$, which is US$4 - 5 per month by direct

Fig 6.15: Low-cost bamboo housing in Ecuador

payment at VHC offices or via a bank. The advantage of paying through VHC is that the client can simultaneously receive medical attention and lunch for themselves and their youngest children, subsidised by the government. They can pay with their social welfare of US$11 per month or other income and in some cases are supported by VHC's charitable funds.

Peoples' main incentive to pay in time is that they want the house to be their own and they are stimulated to take responsibility for the payment and to become independent owners. The women feel in general responsible and are also influenced by the social control of their community and women organisations. Another incentive is a good reputation within VHC and access to the services and the socio-economic support they can offer. VHC has a plan to introduce another incentive in the form of a discount for people who pay in time.

The standard house has a size of 4.80 by 4.80 meters. The house is prefabricated in the factory of VHC. A unit consists of: 8 panels for the walls (3.20 by 2.50 meters), wooden boards (for the floor, the door and 3 windows), 9 wooden pillars, roof sheets and nails. The primary materials are:

- pre-processed bamboo for the walls
- mangrove wood for the pillars
- tropical hardwood for the floor, doors and windows
- zinc for the roof

The walls of the house are made of opened and flattened bamboo strips (*Cana picada*). The species used is *Guadua angustifolia* from different locations on the coast (mostly from Empalme), exploited from natural forests, harvested from Guadua plots on private farmland, and a very small portion from VHC's own 30 hectare Guadua plantation. In the field the bamboo culms are opened by spitting them longitudinally and are transported to the factory by truck in this state before being cut into strips 3 meters long. These are used for the panels. Each house needs 32 pieces of *Cana picada* 3 meters long, and 20 *latillas*, which are small strips of bamboo used to fix the bamboo mats on the wooden frame. The price of the *Cana picada* is US$1 (US$32 per house).

Fig.6.16: Dai Village House

The quality of the bamboo is a problem because no selection takes place of *guadua* plants for exploitation. There is no quality control in the field. The material comes from young, old and even degrading (dry) plants. In addition the raw material is becoming scarce. There is little management of the resource base and the exploitation methods are inappropriate and destructive. Local farmers rarely cultivate bamboo. The bamboo for the panels is not treated against insects or decay, in order not to raise the price, but the clients are advised to do so once they have erected their houses with some simple and cheap methods, combining diesel, oil and some insecticide. Because the houses become more permanent solutions for the poor, treatment is indispensable.

The labourers (*paneleros*) work 6 hours a day and produce 25 panels of 3.20m by 2.50m. They receive US$150 per month (which is a very good salary in Ecuador today). Pneumatic hammers have been introduced recently and make the work easier and faster. As a result less labour is needed and the price of the house can be kept stable.

SUSTAINABLE BUILDING PROGRAM IN CHINA: INTEGRATION OF BAMBOO AND RENEWABLE ENERGY TECHNOLOGIES

Conservation of natural forests is a key issue in China's sustainable rural development. One of the problems in rural China is the use of large quantities of wood and red bricks in house construction. So is the extensive use of firewood as fuel for space heating and cooking. This causes destruction of forests, and as a consequence water shortage and soil erosion problems. In certain areas the annual consumption of fuel wood accounts for some 60% of the total forest consumption after commercial logging was banned in 2000 (Lin, Reijenga & Xuhe, 2002). The scarcity of traditional forest wood resulting from conservation oriented management practices, and constraints associated with the acquisition or use of non-wood materials have attracted attention to the need to find suitable substitutes. In this context, use of bamboo has emerged as an ideal solution.

World Wildlife Fund/WWF China and the International Network for Bamboo and Rattan/INBAR have jointly launched the project 'Promotion of Energy Efficient Buildings: Integration of Bamboo and Renewable Energy Technologies' together with the Urban & Rural Planning & Design Institute

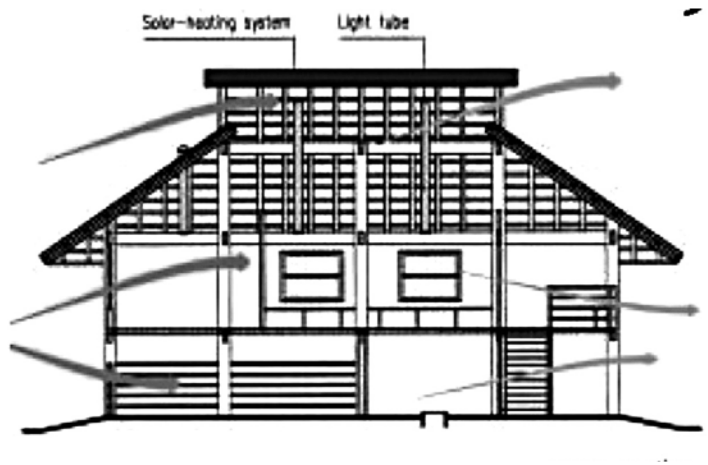


Fig.6.17: Cross section of the Dai Village House. The ridge of the roof has an integrated solar hot water ridge system. Daylight tubes in the roof are used to transport daylight from the outside into the living room.

of Yunnan and BEAR Architecten Gouda (Holland) in March 2002. The objective of the project is to design model houses, hotels and school buildings for rural people in south-western China, particularly in Yuanan Province where abundant bamboo resources are available and which already has a tradition of using bamboo as building material.

The key concept of this project is to link energy savings and the utilisation of renewable energy technologies with the use of bamboo and bamboo panels. The houses will be bio-climatically designed according to the passive solar design principles and installed with a solar thermal water heater, integration of a solar PV system in order to utilize solar energy more efficiently, particularly in cold, high mountain areas. Biogas technologies will be used to utilize waste from humans and pigs. Other energy saving measures will also be used to be adaptable to local climate conditions, such as the use of natural cooling and other techniques. Water saving measures will also be taken to conserve water and minimize environmental impact of wastewater discharge.

Among the projects (model houses, hotels and a school), the Dai Village House[14] is chosen as an example in order to make it comparable to the cases of Costa Rica and Ecuador. The Dai house is designed based on local architecture, using local materials, with improvements on comfort points.

Main construction of the house will be a concrete floor and concrete columns. The floor is thermally insulated with 50 mm of mineral wool. The walls will be framed with bamboo constructions. The roof will be made of plywood (or bamboo boards) with 50 mm of mineral wool insulation and an outside cover with bamboo sheeting. The sheeting is used in two layers to keep the roof cooler. The air gap between the two layers has to be open on both sides for ventilation. In the interior floors and walls will be covered with bamboo flooring and decorative panels. Ventilation openings in all walls on each orientation will give cross-ventilation through the house. The roof has ventilation openings so that the warm air can raise and leave the house. The bamboo walls will give a ventilation airflow through the house as well (see Fig.6.17).

RELEVANCE OF THE EXAMPLES TO THE CONDITIONS IN INDONESIA

The project of Kali Code village is a remarkable case of the role architecture can play in social and community development. It illustrates the importance of an initiator who also acts as a leader and is dedicated all the way through the project, similar to the case of Banjarsari (see Chapter 4.5). The use of bamboo here is an example that even though it is cheap, it gains its value through decoration and the pride/sense of belonging from the inhabitants. If this case is to be applied in other cities, we need more people like Mangunwijaya who are as persistent and dedicated.

Although highly different in area dimensions and numbers of population, Indonesia and Costa Rica share similar geographic conditions: from their tropical climate, dry/rainy seasons and bio-diversity richness, to natural hazards (i.e. occasional earthquakes and active volcanoes) and environmental issues (i.e. deforestation and pollution) (see Table 6.2). Considering the similar potentialities, the Costa Rica project serves as a good example for a bamboo plantation and the establishment of bamboo-based building material sites in Indonesia. Being the origin of hundreds of bamboo species, Indonesia should be able to explore more of bamboo's advantages.

The experience of Costa Rica, especially concerning the continuation of the project discussed, is a valuable lesson if such bamboo-based product enterprise would be established in Indonesia. The local community, especially potential inhabitants of the bamboo housing, should also participate in financing the project and the producer should provide product variations for a higher market (i.e. high quality indoor accessories and furniture).

The Housing Project of Ecuador is an excellent example of housing provision for low-income groups. Even though the government provides subsidies and the involved NGO arranges the administration and production of the houses, the people are actively involved in the process of financing and building their own houses, therefore gaining self-respect and a sense of belonging towards their property. Considering the high percentage of people living below the poverty line (see Table 6.2), cheap shelters are crucial in Ecuador. Although the percentage is lower in Indonesia, the number of cheap shelters might be higher and is also an urgent need, especially in dense urban areas. The large amount of labor force is an advantage that can support a labor-intensive bamboo housing industry in Indonesia. Referring to the case of Ecuador, Indonesia should be able to carry out a similar method to provide such low-cost housing with similar methods:

- by utilizing local resources to gain alternative building materials and to reduce the (transportation and energy) price
- by activating the co-operation system with active involvement from the (potential) inhabitants of the housing

China, also known as 'the land of bamboo curtains', is where over 400 bamboo species originate. Naturally, bamboo has been playing a great part in the life of the Chinese people over the centuries, as well as in Indonesia. The sustainable building program in this example presents bamboo, which is locally available in abundance as one of the main issues in sustainable building concepts and practice. The results show utilization of bamboo as a building material at its utmost performance.

This program provides a valuable insight for sustainable housing in Indonesia. The bioclimatic design approach and the utilization of main local resources fit into the sustainability concept that are discussed in this research.

SUMMARY: THE RELEVANCE OF THE EXAMPLES TO THE SUSTAINABLE HOUSING ASPECTS

Although all examples put forward bamboo as the main building material, there is a notable difference among them. The cases of Yogyakarta, Costa Rica and Ecuador have a similarity in focusing on housing for low-income groups, while the building project in China does not emphasize the economic aspect, but the application of a bio-climatic approach to minimize artificial energy. This difference is apparent from the following analysis of these examples, based on the seven aspects of sustainable housing .

ENERGY

The Kali Code village in Yogyakarta uses conventional energy resources (the state's electricity grid) and local material resources. In the case of Costa Rica, a bamboo plantation was established particularly for the purpose of the housing project, located next to a preservation center. In Ecuador, bamboo and other (raw) materials that are chosen as building elements are available locally, therefore reducing the energy needed for transportation. The project in China focuses on the bio-climatic design (natural cooling by ventilation), utilization of solar energy (i.e. solar water heater, PV system, natural lighting in the daytime) and utilization of biogas technology.

MATERIALS

Although bamboo is used as the main building material, these projects also utilize other materials such as wood (for joints and frames in Costa Rica and Yogyakarta), mangrove wood for pillars and zinc for the roof (in Ecuador) and roof tiles (in Yogyakarta). All materials were obtained locally in order to maintain the low price of the housing. However there is lack of quality control and management of the bamboo resources in Ecuador. The building materials are not readily preserved, therefore requiring the house owner to conduct a treatment (applying layers of oil or insecticides to the bamboo surface) once the house is erected. The project in China aims to reduce logging and usage of wood, and chooses bamboo, which grows locally, as a substitute. In this project, bamboo is used for wall construction frames, roof and flooring (bamboo boards); other materials are concrete (for floors and columns) and mineral wool (as a thermal insulator in the floors and roof).

WATER

There are no specific data concerning the use of water during the building process and the utilization and maintenance of the housing in Costa Rica and Ecuador. In the case of Yogyakarta, being located on a river bank, the village inhabitants make use of the river and also a well, which is located near the houses. At the project in China, it was mentioned that the Dai people are used to drinking water from a well. Water for domestic purposes is heated by a solar heater that is fixed on top of the roof. A tube system in the floor circulates cool water, which aims to reduce the temperature of the floor.

INDOOR ENVIRONMENT

The village houses of Kali Code were built in various dimensions, consisting mainly of one community building, which accommodates gathering sessions and other communal activities, and two residential houses in the form of 'long houses', each provides living spaces for several families. The NBP in Costa Rica adapted the use of bamboo to a modern housing design. There are basically three sizes of houses built by PNB: 31,3 m^2, 37,7 m^2 and 46 m^2, with a total of 20 different layouts. The housing built in Ecuador has the standard size of 4,08 x 4,08 m^2 per unit. The housing in China applies a traditional Dai-style design, around 100 m^2 width (Lin, Reijenga & Suhe, 2002), separated into living room, bedrooms and kitchen (on the elevated floor) and bathroom, storage, pig stable and biogas installation (on the ground floor). These rooms are designed with an orientation that is most suitable for indoor climate control and comfort.

Table 6.2: Data of Indonesia, Costa Rica and Ecuador

	INDONESIA	COSTA RICA	ECUADOR
Area	total: 1,919,440 km^2 land: 1,826,440 km^2 water: 93,000 km^2 (total area of Java Island: 132,000 km^2)	total: 51,100 km^2 land: 50,660 km^2 water: 440 km^2	total: 283,560 km^2 land: 276,840 km^2 water: 6,720 km^2
Climate	tropical; hot, humid; dry season (October to April); rainy season (April to October); more moderate in highlands	tropical and subtropical; dry season (December to April); rainy season (May to November); cooler in highlands	tropical along coast, becoming cooler inland at higher elevations; tropical in Amazonian jungle lowlands
Terrain	mostly coastal lowlands; larger islands have interior mountains	coastal plains separated by rugged mountains, including over 100 volcanic cones, of which several are major volcanoes	coastal plain (*costa*), inter-Andean central highlands (*sierra*), and flat to rolling eastern jungle (*oriente*)
Natural hazards	occasional floods, severe droughts, tsunamis, earthquakes, volcanoes, forest fires	occasional earthquakes, hurricanes along Atlantic coast; frequent flooding of lowlands and landslides at onset of rainy season; active volcanoes	frequent earthquakes, landslides, volcanic activity; floods; periodic droughts
Environment: current issues	deforestation; water pollution from industrial wastes, sewage; air pollution in urban areas; smoke and haze from forest fires	deforestation and land use change, largely a result of the clearing of land for cattle ranching and agriculture; soil erosion; coastal marine pollution; fisheries protection; solid waste management; air pollution	deforestation; soil erosion; desertification; water pollution; pollution from oil production waste in ecologically sensitive areas of the Amazon Basin and Galapagos Islands

Table 6.2: Data of Indonesia, Costa Rica and Ecuador (continued)

	INDONESIA	COSTA RICA	ECUADOR
Environment: international agreements	*party to*: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands *signed, but not ratified*: Marine Life Conservation	*party to*: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Wetlands, Whaling *signed, but not ratified*: Marine Life Conservation	*party to*: Antarctic-Environmental Protocol, Antarctic Treaty, Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands *signed, but not ratified*: none of the selected agreements
Population (July 2005 est.)	241,973,879 Ranks as the 5th most populated country in the world	4,016,173 Ranks as the 125th most populated country in the world	13,363,593 Ranks as the 66th most populated country in the world
Population Growth Rate (2005 est.)	1.45%	1.48%	1.24%
Gross Domestic Products (GDP): per capita*) (2005 est.)	purchasing power parity: $3,700 Ranks as the 150th in the world	purchasing power parity: $10,000 Ranks as the 85th in the world	purchasing power parity: $3,900 Ranks as the 146th in the world
GDP: composition by sector (2005 est.)	agriculture: 15.1% industry: 44.5% services: 40.4%	agriculture: 8.6% industry: 28.3% services: 63.1%	agriculture: 7.4% industry: 31.8% services: 60.8%
Labor force (2005 est.)	110.4 million The 5th highest number	1.82 million The 113rd higest number	4.6 million (urban) The 74th higest number
Labor force by occupation (1999 est.)	agriculture 45% industry 16% services 39%	agriculture 20% industry 22% services 58%	agriculture 8% industry 24% services 68%
Population below poverty line (2004)	15.2%	18%	45%

**) A nation's GDP at purchasing power parity (PPP) exchange rates is the sum value of all goods and services produced in the country valued at prices prevailing in the United States. This is the measure most economists prefer when looking at per-capita welfare and when comparing living conditions or use of resources across countries. For many developing countries, PPP-based GDP measures are multiples of the official exchange rate (OER) measure.*

Source: The World Fact Book, *http://www.cia.org*

SURROUNDING ENVIRONMENT

The design of the Kali Code houses was adjusted to the physical condition of the river bank (i.e. erecting a foundation in the drain). Due to the flexible and spontaneous building process, the appearance of this village has an organic impression. Bamboo houses that were produced in Costa Rica and Ecuador are very much in the style of typical local houses and appear in harmony with their surroundings, while the housing in China is designed according to traditional type of a Dai village.

ECONOMIC

For the building project in Yogyakarta, architect Mangunwijaya and a sector chief induced two local newspapers to provide financial help, mainly through articles about the importance of the inhabitants' role in society. In Costa Rica, the NBP started as a housing project with funding from various resources, endorsed by the government. When the project was completed, the executing organization became a (non-profit oriented) foundation that should support itself. This project has not only provided affordable housing, but also employment and income for the local communities (at the plantation, the treatment/preservation plant and at the production/construction sites). The most important advantage of bamboo housing technology in Costa Rica: the low cost does not sacrifice quality, durability, or space. Instead, it offers an option that is feasible for populations of scarce resources. A PNB house costs US\$ 83/m^2, which is considerable in comparison to the price of a common pre-fabricated house of other materials, equaling about US\$ 111,10/m^2 (Quintans, 1998).[15] An Ecuador bamboo house costs US\$ 450 per unit. In the project in China, the building costs may not be the main concern. However, considering the optimal use of natural lighting and cooling, in the long run the house does save energy expenses.

SOCIAL-CULTURAL

The housing projects in Yogyakarta, Costa Rica and Ecuador, which aim to provide housing for low-income group as a priority, succeed in augmenting self-confidence of the local people, who are actively involved in financing, producing and constructing the housing for themselves. In the case of China, the houses are designed based on the characteristics and traditions of Dai people, who are involved in the discussion of the building project.

In order to confirm the connection between the actors (of housing projects) and the project's highest achievement in certain sustainable aspects (as mentioned in Chapter 5.4), the DCBA guideline is applied to these examples of bamboo housing, in the next section.

6.3 Application of DCBA Guideline in Bamboo Housing Examples

The DCBA guideline for the purpose of comparing the examples of bamboo houses is similar to the DCBA guideline for Sustainable Housing in Indonesia (Chapter 5.2). As mentioned previously, the guideline used for this examples emphasizes environmental sustainability (from D to A represent from the least damaging to the best impact for the environment). The aim of this comparison is to see which quality of each example, holds the most important role in achieving the most sustainable condition. (See Tables 6.3.1 and 6.3)

The project of Kali Code, which is self-initiated, reaches the highest score for material (assemblage and durability) and social-cultural aspects; mostly due to their own efforts in physically building virtually all of their own houses. A strong relationship among the inhabitants is the main key for a self-initiated project to achieve a sustainable environment.

Table 6.3: DCBA Bamboo Housing

ASPECTS	KALI CODE VILLAGE, INDONESIA SELF-INITIATED	NBP, COSTA RICA GOVERNMENTS, (INTER)NATIONAL ORGANIZATIONS	VHC, ECUADOR NON-GOVERNMENT ORGANIZATION	DAI VILLAGE HOUSE, CHINA NON-GOVERNMENT ORGANIZATIONS
1 ENERGY				
Sources	Conventional energy sources D	Conventional energy sources D	Conventional energy sources D	Bio-climatic design (passive solar design principles), solar thermal water heater, solar PV system, biogas technology A
2 MATERIAL				
Resource	Locally grown bamboo, traditional preservation, mixed with conventional building materials (i.e. concrete, wood, roof tiles) C	Locally self-grown bamboo, Boucherie preservation, mixed with conventional building materials (i.e. wood, cement) A	Raw bamboo from natural forests, no preservation after harvest, mixed with woods and zinc (for the roof)	Locally grown bamboo, mineral wool (for insulation) and conventional building materials (i.e. concrete, wood) B
Assemblage	Self-assembled, labour-intensive, intermediate technology A	Self- assembled, labour-intensive, intermediate technology A	Self-assembled, labour-intensive, intermediate technology A	(Not specified) D
Durability & maintenance	Regularly treated; the village has been a tourist attraction for about 20 years since the improvement project started B/A	The bamboo houses have proven to be earthquake-proof B	Treatment to the house right after assembly B/A	(Not specified) Assumption: average treatment of an occupied house B
3 WATER				
Resource	Communal water well D	Water well D	(Not specified) D	Water well, conserve water through saving measures, minimize waste water B

Table 6.3: DCBA Bamboo Housing (continued)

ASPECTS	KALI CODE VILLAGE, INDONESIA SELF-INITIATED	NBP, COSTA RICA GOVERNMENTS, (INTER)NATIONAL ORGANIZATIONS	VHC, ECUADOR NON GOVERNMENT ORGANIZATION	DAI VILLAGE HOUSE, CHINA NON GOVERNMENT ORGANIZATIONS
4 INDOOR ENVIRONMENT				
Space	Standard space width C	Standard space width C	Standard space width C	Standard space width, based on local architecture A
5 SURROUNDING ENVIRONMENT				
Facilities	Adjusted to the physical condition of the river bank, organic impression, one community building, limited but enough public space C	Standard infrastructure facilities (i.e. electricity grid), local style houses, in harmony with the surroundings B	Local style, in harmony with the surroundings, conventional electricity and water source C	Traditional type of a Dai village, applying own water system A
6 ECONOMIC				
Building finance	Donation raised by the initiators and self-financed C	Various resources, endorsed by the government. A	Self-financed; a special credit system: through VHC where clients can receive socio-economic services (i.e. healthcare) as an incentive if they pay in time B	Collaboration of WWF China and INBAR, Urban & Rural Planning and Design Institute of Yunnan and BEAR Architecten (the Netherlands) A
7 SOCIAL-CULTURAL				
Initiators	Kali Code project was initiated and mobilized by a charismatic leader and architect, former priest Mangunwijaya A	The whole project was a co-operating effort of a number of organizations; initiatives are in the form of thorough programs C	VHC acted as an organization who initiated the payment system so the very poor can own their own houses C	This project is initiated by the participating institutions C

Table 6.4: Scores of Bamboo Housing Examples According to the DCBA Guideline

Table 6.4 a: Kali Code, Indonesia

	D	C	B	A
Energy	■			
Materials – resource	■	■		
Materials – assemblage	■	■	■	■
Materials – durability	■	■	■	■
Water	■			
Indoor environment	■	■		
Surrounding environment	■	■		
Economic	■	■		
Social-Cultural	■	■	■	■

Table 6.4 b: NBP, Costa Rica

	D	C	B	A
Energy	■			
Materials – resource	■	■	■	
Materials – assemblage	■	■	■	■
Materials – durability	■	■	■	
Water	■			
Indoor environment	■	■		
Surrounding environment	■	■	■	
Economic	■	■	■	■
Social-Cultural	■	■		

Table 6.4 c: VHC, Ecuador

	D	C	B	A
Energy	■			
Materials – resource	■	■	■	
Materials – assemblage	■	■	■	■
Materials – durability	■			
Water	■			
Indoor environment	■	■		
Surrounding environment	■	■		
Economic	■	■	■	
Social-Cultural	■	■		

Table 6.4 d: Dai Village House, China

	D	C	B	A
Energy	■	■	■	■
Materials – resource	■	■	■	
Materials – assemblage	■			
Materials – durability	■	■	■	
Water	■	■	■	
Indoor environment	■	■	■	■
Surrounding environment	■	■	■	■
Economic	■	■	■	■
Social-Cultural	■	■		

Table 6.4 e: Overall scores for all examples

VARIABLES	CASES	D	C	B	A
Energy	Kali Code	■			
	NBP	■			
	VHC	■			
	Dai House	■	■	■	■
Materials – resource	Kali Code	■	■		
	NBP	■	■	■	
	VHC	■	■	■	
	Dai House	■	■	■	
Materials – assemblage	Kali Code	■	■	■	■
	NBP	■	■	■	■
	VHC	■	■	■	■
	Dai House	■			
Materials – durability	Kali Code	■	■	■	■
	NBP	■	■	■	
	VHC	■			
	Dai House	■	■	■	
Water	Kali Code	■			
	NBP	■			
	VHC	■			
	Dai House	■	■	■	
Indoor Environment	Kali Code	■	■		
	NBP	■	■		
	VHC	■	■		
	Dai House	■	■	■	■
Surrounding Environment	Kali Code	■	■		
	NBP	■	■	■	
	VHC	■	■		
	Dai House	■	■	■	■
Economic	Kali Code	■	■		
	NBP	■	■		
	VHC	■	■		
	Dai House	■	■	■	■
Social Cultural	Kali Code	■	■	■	■
	NBP	■	■		
	VHC	■	■		
	Dai House	■	■		

The NBP in Costa Rica, which was endorsed by the government who collaborated with international organizations, reaches the highest score in economic aspect, due to a secure financial resource during the first phases of the project. The material resource aspects could actually be categorized in A if the preservation process did not use toxic chemical substances. The material assemblage aspect acquires the highest score due to a bamboo plantation and preservation site that were established especially for this housing project, and a labour intensive manufacture and building method.

The housing project in Ecuador by VHC, an NGO which initiated the special housing loan system for the lowest income group, scores the highest at material assemblage since the housing occupants are to build their own houses (the building process is commonly conducted by the house owner and family members who work voluntarily).

The Dai Village House in China, which is initiated by organizations and academic institutions, scores the highest on Energy, Indoor and Surrounding Environment and Economic. The latter is due to secure financial resources, to which the project states that money is not a concern. Therefore the project can set high ambition levels for alternative energy, water system and indoor space. Strong financial backing, bioclimatic design and advanced technology application distinguish this project from the rest of the examples; consequently influencing the high performance for the environmental aspects of this project.

HOW SUSTAINABLE IS BAMBOO AS A BUILDING MATERIAL IN INDONESIA? (RESEARCH QUESTION 3)

The housing project at Kali Code is a an outstanding example of how the properties of bamboo, as a building material, are successfully used. The project has proven that the low price of bamboo does not necessarily produce unattractive housing – on the contrary, it has managed to create a unique and appealing appearance. Beyond the physical performance, the project has also achieved a remarkable example of a bottom-up process in housing development. It can be concluded that housing projects with similar circumstances to Kali Code, including the presence of charismatic initiators who play a key role, are capable of achieving the highest level of sustainability for the Material and Social-Cultural aspects.

To summarize an answer to the Third Research Question of this dissertation: bamboo can be as sustainable as the architects' and planners' capability to understand and enhance the properties of bamboo – not only as a building material, but also as a device to encourage people's participation and promote their self confidence through a housing project. Bamboo as a building material can reach high scores for other aspects under certain conditions, referring to the result of the DCBA qualification of the examples. However, as it is virtually impossible to reach the highest scores for all of the aspects, strategies to score as high as possible for all aspects, considering the conditions in Indonesia, are proposed in the next chapter.

Notes

1. *During the colonial era, the Dutch expressed negative opinions towards traditional houses in Indonesia. They judged these to be dark, smoky, overcrowded and unhygienic (Waterson, 1997). Besides being uncomfortable, dark and humble, the houses were also considered to be a breeding ground for illness and a cause of plague. An attempt to refine the use bamboo as a building material was evident from a manual about improved details of bamboo houses for the interest of the health of the inhabitants published by the Department for Health Care of the Population in 1935. However, efforts to improve housing conditions implied infusion of new building techniques and materials, such as the use of corrugated iron roofs and bricks and concrete in construction (Nas, 1998).*

2. *Log consumption in Indonesia for the timber industry (plywood, sawmill, pulp and paper): 63 million m^3/year, for building construction: 25 million m^3/year, smuggled out: 10 million m^3/year (Ministry of Environment, 2003).*

3. *See separate box:* What is the difference between a hardwood and a softwood? (p. 99).

4. *Most known data about the amount of saved tropical forest, if bamboo substitutes wood as a building material, come from Billing & Gerger (1990). The result states that, in the case of the National Bamboo Project in Costa Rica, the demand for wood can not be reduced by more than 7%, which corresponds to approximately 4200 ha of forest per year. Considering the irreversibility of the deforestation, however, even this small contribution is important.*

5. *Bamboo carpentry is different from wood's, particularly in the joints techniques, due to the constraint of bamboo's natural shape: hollow, tapered, with nodes at varying distances and not perfectly circular (Janssen, 2000).*

6. *Compared to 'permanent' building made of hardwoods such as teak and cengal (*Balanocarpus heimii*) in Sumatra, or ironwood (*Eusideroxylon zwageri*) in Kalimantan, which can endure up to 150 years.*

7. *These methods are also categorized as non-chemical protection measures (Liese, 2003).*

8. *Effective and safe chemicals are based on the element boron, i.e. boric acid, borax and boron (Janssen, 2000). See Appendix D for more details about bamboo preservation.*

9. *In several applications, bamboo proves more than 20 times as ecological as the common western building materials timber, steel and concrete (van der Lugt et al., 2003).*

10. *The LCA and EVR calculations are not conducted in this research, due to limited research scope (see Chapter 7.3 Recommendations for elaboration).*

11. *In the case of Costa Rica, bamboo houses are about 20% cheaper than the usual type of social housing, without sacrificing quality, durability, or space.*

12. *Studies show that the energy required for processing bamboo requires only 1/8th of concrete and 1/3rd of wood in order to create a building material of the same capacity. In comparison to steel bamboo needs only 1/50 the amount of energy for processing (Roach, 1996)*

13. *In Costa Rica, 30 houses that were in the epicenter of 7.6 magnitude rector scale earthquake survived without any damage, while many of the concrete homes and hotels around them collapsed (Gutiérrez, 1998).*

14. *The Dai religion is Buddhism; the Dai people believe in and worship Buddha in their village's temple, which holds the most important position of the village, has the best scenic setting and is surrounded by houses.*

15. *The difference in material prices is considerable in comparison to 'modern' materials. For instance, a concrete block wall costs about US$ 38/linear meter while* cana brava *panel costs about US$ 26,25 (Picado, 1992).*

7. FUTURE USE OF BAMBOO AS A BUILDING MATERIAL IN INDONESIA

This chapter discusses the feasibility of the use of bamboo as a building material in Indonesia. The first part of this chapter presents a list of requirements for bamboo housing projects. The second part describes the impacts of using bamboo as a building material on the other aspects of sustainable building, as visualized in the 4P figure. Finally, this chapter proposes recommendations for future (sustainable) use of bamboo as a building material.

7.1 Requirements for Bamboo Housing Projects

The positive results of the examples mentioned are an encouragement for Indonesia to take similar actions. However, the following requirements (Janssen, 2000 and Paudel, 2004) should be taken into account:

- *Resources*. Bamboo resources of suitable species should be available in abundance, especially for a low cost housing project. Availability of naturally-grown bamboo groves is a good start for a new or expansive plantation. Calculations of timing, size of plantation and amount of materials supply needed for the project should be carried out thoroughly.
- *Target group*. Needs and interests of potential inhabitants of the housing should be assessed properly. Communities who are already familiar with bamboo, possessing skills in bamboo treatment and traditions, are easier to work with. However, it is important to consider their acceptance of bamboo and to evaluate other natural resources that are locally available in abundance. Design of the housing should be flexible and adapt to the long-established domestic customs of the aimed communities.
- *Cost*. It is essential to have a thorough calculation concerning the cost of the project. Strategies are needed not only to finance the plantation, processing the materials and building the housing, but also to ensure continuity of the project, preferably based on the communities' ability to sustain themselves financially. Donors like to fund projects that contain mechanisms to ensure financial autonomy at the end of the project period.
- *Policy*. Government support in the form of policy issue is important, especially in the case of low cost housing projects; not only in the form of subsidies (for accessible land, affordable building materials, etc.), but also in facilitating self-financing communities, funding organizations and supporting institutions. It should be kept in mind that once the project ends, the executing organization should register as a cooperative or foundation, according to the law of the land, so that the legal responsibilities and liabilities are clear.

7.2 Impacts on Other Aspects of Sustainable Building

The improved use of bamboo as a building material, whether using traditional, intermediate or advanced technology (see Table 12 at Chapter 6.1), has positive impacts on all areas of a built environment. The 4P figure is used to illustrate the impacts of using bamboo as a building material (which falls under Planet) on Planet, Prosperity, Project and People.

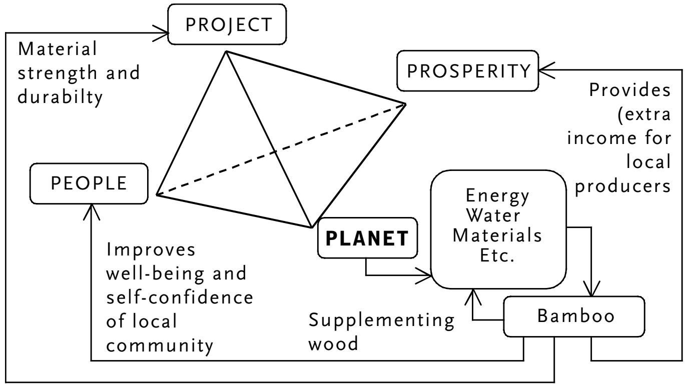


Fig. 7.1: The impacts of using bamboo as a building material (Planet) on the three other P's (People, Project and Prosperity).

PLANET (ENERGY, WATER, MATERIAL, PURENESS, MOBILITY, WASTE)

- Bamboo can help supplementing or substituting wood as a building material. The use of bamboo as wood supplement will save tropical, (hard)wood forests from exhaustion, due to exploitation.
- Bamboo provides protection to its surroundings (preventing landslides, preserving soil water, functioning as a wind breaker, a habitat for some species, etc.). The regular use of bamboo would mean enforcing bamboo plantations, which have positive impacts on their surrounding environment as mentioned before.

PEOPLE (HEALTH, FREEDOM, PARTICIPATION, SAFETY)

- Empowerment of and rewards for the skills and knowledge of local human resources (at the preservation and production site) will give the people self confidence and pride.
- Established plantations and production units, which are mostly located in rural areas, will ensure continuous occupation for plantation-keepers.
- Traditional skills are preserved and improved

PROJECT (RELATIONSHIP THROUGH SCALES, ROBUSTNESS, BEAUTY, BIODIVERSITY)

- Bamboo board has a highly aesthetic quality when used for indoor elements and products
- Bamboo provides new challenges for material treatment and usage
- Recent contribution to the field of material and construction sciences: international building standards for bamboo

PROSPERITY (PROFIT, TRANSPARENCY, PAYABILITY, HONESTY)

- Production of bamboo as a construction material in village production units provides an income source for villages
- Established plantations of natural resources with high economic value provide steady jobs for local communities.
- The use of locally-grown bamboo in housing projects reduces material and transport costs.

7.3 Recommendations for Future Application

In 2004, two ISO[1] standards and one technical report have been published concerning the use of bamboo as a structural material and concerning the determination of physical and mechanical properties. Such standards may not be needed if the use of bamboo as a building material is limited to rural areas. However, if bamboo is expected to perform optimally, requirements are necessary for the following issues: prefabrication, industrialization, finance and insurance of building projects, export and import, and more items for which standards are a requirement. These international standards are a great step forward for bamboo on its way to recognition as a fully developed building and engineering material (Janssen, 2005). As a concluding remark, Janssen urged bamboo growing countries to create national bamboo standards based on these international ones. Therefore, as the country of origin for 11% of all bamboo species and five of the 19 most valuable bamboo species worldwide (Larasati, 1999), Indonesia is strongly recommended to develop its own national standards for bamboo as a building material.

Research of the environmental and economical value of bamboo housing in Indonesia should be carried out, especially in comparison with the use of other natural resources. Instruments such as Life Cycle Assessment (LCA) and Eco-Value Ratio (EVR) can be used to measure the level of sustainability in selected areas.

Considering the proportion of the subject of bamboo in this research, the LCA and EVR of bamboo building are not discussed in depth. Other constraints are that resources and data from Indonesia, that are needed as variables for these calculations, are not available or not easily accessible. Therefore an investigation that specifically aims at the LCA and EVR of bamboo building in Indonesia is recommended for further research.

A Masters' thesis by Pablo van der Lugt (2004) has included an LCA to investigate the sustainability of bamboo as a building material in Western Europe. His conclusions state that bamboo is most sustainable in its natural form (the culm), while in the industrial form (i.e. bamboo boards) the environmental advantages of the bamboo culm are lost.

Investigations on bamboo utilization have provided results that have been tried out in practice, along with an analysis of their success and failure. A quantity of expertise in various subjects concerning bamboo are accessible (among others through the International Network of Bamboo and Rattan/ INBAR). Therefore, from the current situation onwards, knowledge and technology transfer is most important in order to achieve maximum benefit from bamboo.

Notes

1. *ISO (International Organization for Standardization) is the world's largest developer of standards. International standards provide a reference framework, or a common technological language, between suppliers and their customers, which facilitates trade and the transfer of technology. (ISO, 2005, at http://www.iso.ch/iso/en/aboutiso/introduction/ index.html)*

Team work of hoisting a wall panel during a house construction process in Thailand (shown to present how walls of houses in South East Asia are generally light and non load-bearing) / Photo: Dorothy Pelzer Collection, courtesy of ISEAS, Singapore / Source: Roxana Waterson. 1997. The Living House*, p. 75*

8 CONCLUSIONS & RECOMMENDATIONS

This research started with references to a number of sustainable building concepts which mostly originate from developed countries, whose conditions are different from those in Indonesia. In the case of Indonesia, the most significant characteristics that have an impact on sustainable building practices are: climate, high population numbers and numerous natural, human and cultural resources that are spread all over the archipelago. The (dis)advantages of these conditions are discussed in the Conclusions section.

This research encourages the role the local community that is involved can play in a housing project and aims to produce results that can be understood by common people. According to this research, a good practice of sustainable housing implementation in Indonesia is one that:

- allows community participation
- makes use of local natural resources and materials
- acknowledges skills and capacities in the community involved
- attempts to discover local solutions

The DCBA method, which is proposed as a discussion tool and as a measurement tool for sustainability levels among comparable cases, is put forward as an appropriate method that can be used to stimulate the good practice of sustainable housing implementation that was mentioned previously. Being comprehensible, and at the same time flexible, the DCBA table that is produced by this research tends to be too general, or not detailed enough for engineers and technicians who need specific calculations.[1] However, for further application, the contents of the DCBA table can be modified and developed into a more specific assessment, according to local needs, potentials and requirements of parties involved.

In order to demonstrate an analysis of sustainable housing, this research focused on bamboo, which is considered a promising option for a sustainable building material in Indonesia. The results show that the use of bamboo can have positive impacts on the other sustainability aspects as well (see the 4P-tetraeder at Fig. 7.1).

8.1 Conclusions

As the concluding part of this dissertation, this chapter attempts to provide an answer to the main research question: *How can the concept of sustainable housing be implemented in Indonesia?* A brief answer is: by recognizing and strategically employing the specific potentials of Indonesia that are relevant to sustainable housing. An elaboration concerning these potentials is provided in the following part.

From the analysis and examples that were discussed in the previous chapters, a number of particular characteristics of Indonesia can be derived that are beneficial for sustainable housing implementation. Considering the extensive territory of the Indonesian archipelago, the environment and cultural characteristics from one region to another have their own specific qualities and conditions. The characteristics that are presented here are the ones that apply to the general conditions in Indonesia:

- The practice of *gotong royong* (a form of informal economy in Indonesia), whereby people in local communities work together voluntarily to self-build a house or a communal building, becomes a strong capital for communities who mainly rely on self-support, instead of external financial resources (see Chapter 3.4).
- Relatively steady temperatures and weather throughout the year, which allows employing one strategy in order to create indoor comfort: application of construction principles for a wet-tropical climate, emphasizing natural cooling methods (see Chapter 5.1).
- A great diversity of natural resources, which gives opportunities for the development of alternative energy applications and alternative building materials. One example is the use of bamboo, one of the best options for alternative building materials, provided that its cultivation and utilization are calculated thoroughly and conducted in the region of its origin (see Chapter 7.1).

There are also a number of unfavourable factors relevant to housing conditions in Indonesia that have to be taken into account:

- High humidity,[2] which means that thorough attention must be given to the preservation and maintenance of building materials, in order to achieve optimum durability. This condition can be coped with by employing construction principles for wet-tropical areas (as mentioned in the set of requirements for sustainable housing in Indonesia, Chapter 5.1).
- The lack of interest from community members to participate in improvement projects which requires up to 80% of the community members to be successful. In the case of KIP and Banjarsari (Chapter 4.2 and 4.5), this challenge was met by consistent initiators of the project, who act as the main motivators of the whole activities.
- Distribution of facilities, knowledge and resources throughout Indonesia. The great diversity of Indonesian people, cultural and natural resources is a potential, but can also be seen as a challenge, since each region requires specific treatment. Therefore it is strongly suggested that decisions for a determined region are made locally.

The topic of *sustainable housing* involves not only the physical substance of the building itself, but also the intangible circumstances around it, such as economic and social-cultural factors. Therefore, interdisciplinary cooperation is required in the development of its concepts, in order to achieve a comprehensive result.

Applied research of sustainable housing uses existing situations as its 'laboratory', whereby cases are studied and analyzed. Practical problems and other obstacles in the field become valuable input and an important consideration in the drawing of conclusions, which are aimed to be implemented back to the real situation.

The DCBA booklet that was produced to supplement this dissertation was intended to be a communication tool for all those involved in a housing project. It is expected to function as discussion material in the decision making process; also in urgent or emergency situations where quick decisions need to be made along with beneficiaries, such as in disaster areas. It is an answer to one of the motivations of this research that is mentioned in the first chapter: to accommodate the needs and desires of occupants by involving them in the housing development process. A booklet that consists of an illustrated guideline will help people understand the subject matter more easily.

8.2 Recommendations

Each region in Indonesia has its own characteristics and potentials. One area can be very different from another, therefore strategies for sustainable housing implementation should fit each specific situation. However, strategies for general conditions in Indonesia can be recommended:

TECHNOLOGY/RESEARCH

- *Knowledge dissemination.* Comprehensive knowledge and technology dissemination concerning the use of alternative energy resources and building materials, adjusted to local conditions. This should include preservation and maintenance methods for building materials in a hot-humid climate (see also Chapter 6 about bamboo preservation as an example). This proposition needs co-operation among policy makers (who should encourage practice and implementation of research findings), research institutions (whose interests of their experts play a crucial role) and inhabitants of housing areas (whose participation determines the level of success). This dissertation, which offers a practical guideline and discussion tool for users as one of its outcomes, is an example of this proposition.

- *Natural substances.* Development and production of natural substances based on traditional formulas (i.e. cleaning agents, insect repellents), which lead to the cultivation of raw material resources on a household level (as in the case of PPLH Seloliman and Banjarsari). In order to achieve continuous accomplishment in this matter, it is important for the inhabitants to maintain a regeneration of their skills and for research institutions to contribute input, supervision and improvement whenever necessary.

- *Quantitative research.* Research consisting of a quantitative comparison between conventional and sustainable housing. Calculate, for instance, the impacts of using a solar panel as opposed to a conventional electric supply (see Chapter 5.1), or of using bamboo (a presumably sustainable building material) compared to conventional building materials (see examples in Chapter 6), or the (dis)advantages of implementing sustainable housing concepts, and translate the results into currency values. A positive result could trigger housing companies and (financial) sponsors to invest in sustainable housing development. Academics and research institutions hold a major role in this proposition.

- *Contemporary bamboo design.* Encouraging the use of bamboo in contemporary architecture and design to demonstrate the potential of bamboo as a building material. A successful case will elevate the status of bamboo, especially among the people from where it originates, therefore promoting the development and exploration of this valuable local resource. A similar strategy could also be applied to other indigenous natural materials which are actually advantageous, but are underrated and unpopular compared to conventional building materials.

SOCIAL/CULTURAL

- *Legal performance.* Law reinforcement concerning housing and infrastructures regulations, in order to cope with frail legal performance, especially concerning housing provisions for low income people in dense urban areas (see Chapter 3.1). This proposition mainly requires action by the government and policy makers.

- *Co-operation among actors.* Encouraging forms of co-operation among the actors of a housing project (government, developers, organizations and potential inhabitants), which accommodate community participation in the planning process. In this phase, the DCBA method can be used as material for discussion. Co-operation can also concern the finance of a housing project, which will result in promoting a sense of belonging, responsibility and self-respect for the inhabitants. These activities need initiative from the (potential) inhabitants of a housing project or their representative organizations, the developers and the government.

- *Community participation.* Encouraging active community participation in maintaining a clean environment and reducing household waste. The experience of Banjarsari (Chapter 4.5) should become an example for other villages in Indonesia, which requires committed initiators and efforts from the inhabitants themselves.

- *Social and cultural aspects.* Placing social and cultural aspects of (potential) inhabitants as one of the main considerations in the planning, designing and building of a housing project, by involving the inhabitants as much as possible throughout the whole building or neighbourhood improvement process (see Chapter 6.2, an example from Kali Code village). Consequently, the inhabitants will gain self-respect and a sense of belonging to their domestic environment; a much better result compared to a situation in which the housing concept or design is imposed upon community members who are regarded as objects, not subjects.

- *The role of an initiator.* Providing an initiator, a key person in a community housing project, whose role is thorough and consistent throughout the whole process. Referring to the example of Banjarsari (Chapter 4.5) and Kali Code (Chapter 6.2), successful initiators should respect and understand the hierarchy of the local people, be flexible in finding alternative solutions during the process, yet be consistent in pursuing the goals of the project.

These recommendations are what is believed to be the correct direction to achieve sustainable housing conditions in Indonesia, considering the starting point of this research:
- acknowledge skills and capacities of the local community
- attempt to discover local solutions
- make use of local materials and natural resources as much as possible
- stimulate community involvement and a feeling of ‘ownership’
- allow community participation

The research and technology part should convince policy makers and investors to support the proposed lifestyle by providing quantitative insights and analysis of the advantages. The social and cultural part should be a guideline for common citizens to start their own initiatives, for the will to adopt a sustainable lifestyle should happen from the bottom up. Multi-national organizations and governments may act as initiators of sustainable lifestyles; however, in the end, the success level is determined by the participation and willingness of the local communities.

Notes

1. *The DCBA table is also used as the basis for the booklet entitled* Guideline for Sustainable Housing in Indonesia, *which was produced as a supplement for this dissertation (see Chapter 8.1).*

2. *In Rain Season, relative humidity is between 60% to 94%; in Dry Season 50% to 90%.*

3. *30,000 copies of this book were distributed within Tsunami affected areas in Aceh. Source: UN-Habitat Indonesia Newsletters, 4 May 2006, No. 06 06, accessible at http://www.unhabitat-indonesia.org/newsletter/06/index.htm and United Nations Human Settlements Program (UN-HABITAT) at ReliefWeb, 15 May 2006, accessible at http://www.reliefweb.int/rw/rwb.nsf/db900SID/EVOD-6Q3DF5?OpenDocument*

House in Kali Code, Yogyakarta, where Mangunwijaya (the architect who initiated and designed the village) lived for a period (see p. 100) / Source: Duivesteijn en Van de Wal. The Hidden Assignment. *1994, p. 59*

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APPENDIX A: Indonesia Facts & Figures

The Indonesia archipelago lies on the equator line and is located at:
- 6°N to 11°S in latitude
- 95° to 140° E in longitude

As a national entity Indonesia covers most of the East Indies between the mainland of South East Asia and Australia.

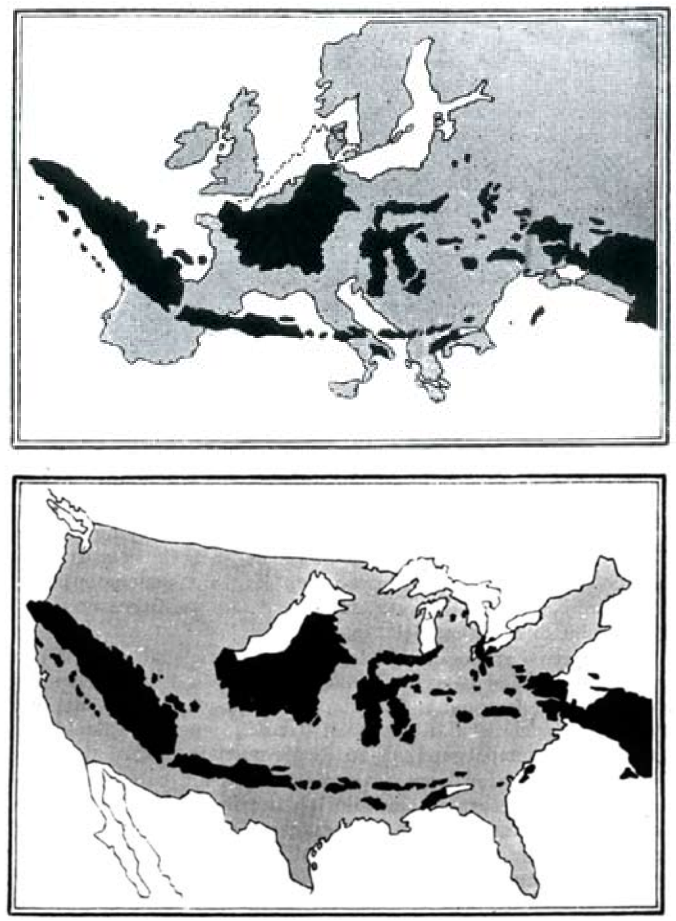

Fig A.1: Area comparison: the Indonesian Archipelago, projected to European and American continents (Djojodihardjo, 1949).

Indonesia has a warm and humid climate and has two main seasons:
· Rain season (December to March)
· Dry Season (September to November)

Table A1: Facts about Indonesia

FACTS ABOUT INDONESIA	
AREA	total 1,919,440 km² land: 1,826,440 km² water: 93,000 km²
GEOGRAPHY – NOTE	Archipelago of 17,508 islands (6,000 inhabited); straddles equator; strategic location astride or along major sea lanes from Indian Ocean to Pacific Ocean. 3/4 of Indonesia contains of five main islands of Sumatra, Java, Kalimantan (Southern Borneo), Sulawesi (Celebes), and West Papua (The Western end of New Guinea), which also includes 4/5 of the population.
POPULATION (EST. JULY 2006)	245,452,739 inhabitants
POPULATION (NOTE)	About 59.19% of population are living in Java Island, which has a population density of 16,333 people per km² (data 2000). Jakarta is the most dense in a top which has population density of 12,635 people per km².
POPULATION GROWTH RATE (EST. 2006)	1.41%
RELIGIONS (1998)	Muslim 88% Protestant 5% Roman Catholic 3% Hindu 2% Buddhist 1% other 1%
LANGUAGE	Indonesian
ETHNIC GROUPS	Javanese 45% Sundanese 14% Madurese 7.5% coastal Malays 7.5% other 26%
ADMINISTRATIVE REGIONS	30 provinces, 2 special regions and 1 special capital city district

Temperature: warm; diurnal temperature: narrow.
Relative humidity: 80-90% during morning time, 40-60% during daytime.
Temperature fluctuation: between 23° in night time and 32° in daytime.
Rainfall may reach to 600 mm per month within the rainy season.
Monthly radiation could reach more than 6000 W/m².
The wind has two main directions: South East Wind (April to October) and North West Wind (October to April). Precipitation is usually high, especially in the western regions like Java and Sumatra, with less rainfall in the eastern regions.

Characteristics of humid tropical climate are *high temperature* and *humidity*, *low average wind speed*, *high solar radiation* but *overcast* (see Table A.2 for an overview of the climate in Indonesia). Other strong character of a humid tropical climate is that there is no significant change between night and day temperature and relative humidity, also between seasons.

Table A2: Overview of Indonesian Climate

INDONESIAN CLIMATE OVERVIEW	RAIN SEASON (DEC-MAR)	DRY SEASON (SEP-NOV)
Average maximum temperature	31.0 °C	33.2 °C
Average minimum temperature	25.0 °C	25.6 °C
Temperature fluctuation in one year	4.5 °C	
Average air humidity	88%	70%
Average relative humidity	60% - 94%	50% - 90%
Average duration of solar radiation	7.8 hours	11.4 hours
Rainfall per month	280.6 mm	142.2 mm
Average wind velocity	1.0 – 2.5 m/sec	1.0 – 4.3 m/sec
Dominant wind direction	West	East
Periods without wind	35%	22%
Global irradiant (max)	780 Wh/m²	1300 Wh/m²

APPENDIX B: Timeline of Co-operation History in the Netherlands and Indonesia

In The Netherlands, housing co-operations started in the 19th century when the Christian and social democratic parties attempted to provide better living conditions for the working class. Initially, there was no relationship between social housing organizations and the government in this initiative. In 1901 the Housing Act was declared, making it possible for private organizations to build 'for the general good' (with government support); aiming at groups of people who could not afford their own housing. The number of such organizations multiplied along the years, building up to 96,600 dwellings of excellent quality up to the pre-war production peak.

- Housing production almost collapsed in the 1930s during the crisis period, and later due to the Second World War. The government then had to provide affordable housing, emphasizing quantity instead of quality.
- In 1967 the housing production still could not catch up with the backlog. In order to reduce the enormous costs of all this building, more attention was given to increasing efficiency, which was achieved mostly through mass production, in the form of high-rise building.
- In the 1980s the government no longer considered housing to be a major priority; loans to social housing organizations were ceased. In the 1990s the government pulled back even further from social housing; capital subsidies (for housing development) were reduced and rent subsidies (for individuals) were increased.
- The end of 1993 saw an agreement between the State, both of the national federations of social housing organizations (NWR & NCIV) and the Association of Dutch Municipalities (VNG), which positioned the social housing organizations to be financially independent. Since 1995 the State no longer provides subsidies.

Table B1: Timeline of housing cooperations in the Netherlands

THE NETHERLANDS		
PERIOD	MILESTONES	OCCURRENCE
1890		40 social housing organizations
1901	Declaration of the Housing Act	Allowed private organizations (legal term: 'registered social housing organization') to build, rent, manage and sell housing, aiming at groups of people who could not afford their own housing..
1913		301 social housing organizations
1914-1918	World War I	
1916-1925	Pre-war production peak	At the time, the social housing organisations built 96,600 dwellings, mostly of excellent quality.
1922		1341 social housing organizations (each owning an average of 30 to 50 dwellings)
1933-1939	Crisis years	Housing production almost collapsed
1939-1945	World War II	
1950s	Post war era	The government had to provide affordable housing through a broad program of subsidies, emphasizing quantity over quality.
1958		The annual production reached 89,000
1967	Cost cutbacks	The annual production reached 125,000 and still couldn't catch up with the backlog
		Building costs had to be reduced by mass production of high-rise building.
		The social housing organisations functioned as nothing more than government branch offices, since it was primarily the local city authorities who determined policies (i.e. the choice of architects, the way contracts were tendered, supervision during construction, the housing allocation).
		The State made a great deal of capital available in the form of subsidies and loans so that a great wave of construction could be set in motion.
1980s	Enormous national debt forced cutbacks	The government changed role; loans to social housing organizations ceased.
		Housing demand no longer considered a priority

Source: 'Dutch Social Housing in a Nutshell' by Aedes vereniging van woningcorporaties, 2003 and the Indonesian Ministry of Cooperative, Small and Medium Enterprises

Table B2: Timeline of housing cooperations in Indonesia

INDONESIA		
PERIOD	MILESTONES	OCCURRENCE
19th century	NV Volks Huisvesting	Established by the Dutch-Indies colonial government to build housing in big cities, public housing in villages and village improvement.
1896	A bank for civil servants	The establishment of a bank for government offical staffs in Central Java, which introduced the first cooperative ideas.
1908	Budi Utomo	The founding of Budi Utomo, an institution that played an important role in the cooperative movement.
1914-1918	World War I	
1927	*Serikat Dagang Islam* (SDI)	The establishment of the Islamic Trader Union (SDI), in order to gain bargaining power among indigenous entrepreneurs.

1929	*Partai Nasional Indonesia* (PNI)	The establishment of the Indonesian National Party (PNI), which introduced and spread cooperation system.
1930	Cooperatives Bureau	The Dutch-Indies government constituted a Cooperatives Bureau under the Ministry of Domestic Affairs
1939-1945	World War II	
1942 - 1945	Japanese occupation era	The Cooperatives Bureau became a part of the People Economi Office.
1947	Congress of Cooperation Movement	July 12th, 1947, the Cooperation Movement held a congress in Tasikmalaya, West Java. The date (July 12th) was declared as the national Cooperation Day..
1950s		The Cooperatives Bureau became independent as Cooperative Department
1952	Housing Department	The Housing Department was established after the forming of a Public Housing Development Treasury Foundation.
1966		The Cooperative Department became Trading and Cooperative Ministry
1972	The first urban study	Sponsored by the World Bank
1974	BKPN, *Perum Perumnas*, BTN	Establishment of the Agency for National Housing Policy (BKPN) and the National Urban Development Corporation (*Perum Perumnas*) and the State Savings Bank (BTN).
1974-1982	The 1st period of *Perumnas'* work	Thousands of housing were mass-produced
1982-1991	The 2nd period of *Perumnas'* work	The state's investment was stopped, market economy system became effective in 1998.
1992-2003	The 3rd period of *Perumnas'* work	*Perumnas* sustained itself based on its own financial capital.
1997	Monetary crisis	The buying power of the lower-income group decreased sharply.
		The housing market became more competitive, due to the more critical customers.
2003 – present	*Perumnas* cooperated with various institutions	Cooperation of *Perumnas* with various institutions (i.e. the army/police force, regional government, private sectors) has resulted in more than 35.000 housing units.

Source: Ministry of Cooperation, Small and Medium Enterprises, Republic of Indonesia - http://www.depkop.go.id

The Public Works Department of Indonesia has published a technical guideline for Healthy Modest Housing (*Rumah Sehat Sederhana*/RsS), which contains comfort, safety and health requirements of affordable housing for different regions in Indonesia.[1] Therefore the general guideline is supplemented by the following technical guidelines:

- Technical Guideline for RsS, Brick House
- Technical Guideline for RsS, Brick House, Elevated
- Technical Guideline for RsS, Wooden House
- Technical Guideline for RsS, Wooden House, Elevated

These technical guidelines are divided based on the characteristics of different regions, known as the four 'RsS Zones' – which is a macro scale and still have to be defined into micro scales for province and district/city levels. These guidelines are aimed at people in the low and very low income groups, or whose income source is in the informal sector.

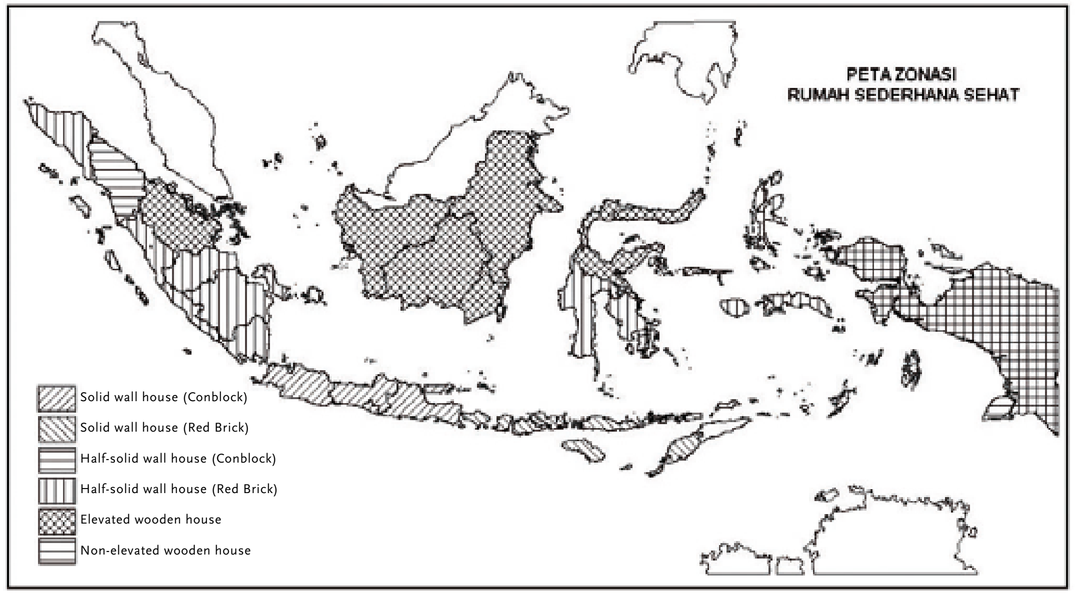

Fig. C.1: RsS Zoning Map for Healthy Modest Housing

According to *Rumah Sederhana Sehat (Rs Sehat)*, a paper about healthy modest housing that was published by *Balitbang Puskim*, *Kimpraswil* (2003),[2] the division of modest housing architecture zones in Indonesia takes the aspects of social-cultural, potential building materials and geological/land characteristics into consideration. Concerning the choice of building materials, considerations are apparently influenced by the prices of conventional building materials. The paper illustrates the case by comparing solid-wall houses in Papua and Java: the price of a solid-wall house in Papua will be almost twice the one in Java. This is due to the high price of cement-based materials in Papua, which can reach up to ten times the price of the same materials in Java. Therefore, in order to maintain

Table C1: RsS Typology Alternatives

PROVINCES	MATERIALS AND LAND CONDITION ZONES	ALTERNATIVES OF APPLICABLE HOUSE TYPES*
Bali Nusa Tenggara Barat Nusa Tenggara Timur	*Pasangan*** > tegakan**** Dry land Clay	Solid wall (red brick)
DKI Jakarta West Java Banten Central Java East Java Yogyakarta	*Pasangan > tegakan* Dry land Sand	Solid wall (conblock)
Nangroe Aceh Darussalam West Sumatera Jambi Bengkulu South Sumatera Bangka Belitung Lampung South Sulawesi South-East Sulawesi	*Pasangan = tegakan* Wet land Clay	Half solid wall Solid wall (red brick) Wooden, elevated Wooden, non-elevated
North Sumatera	*Pasangan = tegakan* Wet land Sand	Half solid wall Solid wall (conblock) Wooden, elevated Wooden, grounded
Maluku North Maluku	*Pasangan = tegakan* Dry land Clay	Half solid wall Solid wall (red brick) Wooden, elevated Wooden, non-elevated
Riau West Kalimantan Central Kalimantan South Kalimantan East Kalimantan Central Sulawesi North Sulawesi Gorontalo	*Pasangan < tegakan* Wet land Clay	Half solid wall Solid wall (red brick) Wooden, elevated Wooden, non-elevated
Papua	*Pasangan < tegakan* Dry land Sand	Half solid wall Solid wall (conblock) Wooden, elevated Wooden, non-elevated

** The alternatives of house types are based on the latest progress of available potential local building materials. The choice of elevated or non-elevated house is based on local architecture/culture.*

*** Pasangan material = building material of anorganic raw materials extracted from nature. If these materials are assembled or applied as a building material, hydraulic cement is required as an adhesive.*

**** Tegakan material = building material of wooden material as a result of wood processing that is acquired from conversion of logs into beams, boards, or other forms according to needs.*

similar prices between modest houses in Java and Papua, it is proposed for Papua to build their houses with wood. It should also be noted that, if a region plans to establish cement-based building material production, it should calculate the amount of energy and resources from outside the region that are needed in the process, which will usually increase the price of the final product. Therefore the choice of using local materials is seen as the best way to maintain similar prices among modest houses throughout Indonesia.

The use of bamboo as a building material, that is proposed by this thesis, is not encouraged in the existing technical guidelines for modest housing. This is due to the fact that national building codes and standards for bamboo as a construction material do not exist, which makes it difficult for architects, engineers and developers to calculate the design, construction and expenses of a housing project. The approval of the Bamboo Building Code by the International Standard Organization has resulted in international standards for:

- Bamboo structural design, which applies to the use of bamboo structures, i.e. structures made of bamboo (round bamboo, split bamboo, glued laminated bamboo) or bamboo-based panels joined together with adhesives or mechanical fasteners. This international standard concerns the requirements for mechanical resistance, serviceability and durability of structures.
- Determination of physical and mechanical properties of bamboo, which covers tests on specimens of bamboo in order to obtain data that can be used to establish characteristic strength functions and to arrive at the allowable stresses. The data can also be used to establish the relationship between mechanical properties and factors such as moisture content, mass per volume, growth site, position along the culm, presence of node and internode, etc., for quality control functions. This document lays down methods of tests for bamboo for evaluating the following characteristics: physical and strength properties: moisture content, mass per volume, shrinkage, compression, bending, shear, and tension.
- Laboratory manual on testing methods for determination of physical and mechanical properties of bamboo, which provides guidelines for staff in laboratories of how to perform tests according to the 'Determination of physical and mechanical properties of bamboo' document.

It is expected that the adaptation of these international standards to Indonesian (or even regional) standards will encourage the exploration and application of bamboo.

However, common perceptions towards solid-wall houses as 'permanent', 'city house', 'higher social status', etc. have been discouraging people to accept houses that are not built with solid materials (i.e. bricks, concrete) as permanent houses. The *Rs Sehat* paper mentioned that these perceptions should actually be overcome, based on the fact that wooden houses (i.e. in Puncak, Bogor, or Lembang – all are in West Java) possess aesthetic values as well.

As proven by the examples in Chapter 6, bamboo housing can be both functional (adequately serving as robust shelters) and desirable (succeeding in gaining a sense of belonging from the occupants). Housing programs in Indonesia should consider a bamboo-based housing project, similar to the case of Kali Code in Yogyakarta, but aimed at higher income groups, with the purpose of gaining (back) people's respect and interest towards bamboo, local wood types, and other indigenous resources that are actually competent building materials.

Table C2: Requirements of minimum building area and land for Healthy Modest House

STANDARD PER PERSON (M²)	HOUSE UNIT	AREA WIDTH (M²) FOR 3 PEOPLE			HOUSE UNIT	AREA WIDTH (M²) FOR 4 PEOPLE		
		Minimum	Effective	Ideal		Minimum	Effective	Ideal
STANDARD (7,2)	21,6	60,0	72,90	200	28,8	60,0	72,90	200
INDONESIA (9,0)	27,0	60,0	72,90	200	36,0	60,0	72,90	200
INTER-NATIONAL (12,0)	36,0	60,0	---	---	48,0	60,0	---	---

REQUIREMENTS FOR HEALTHY MODEST HOUSES

- Space: minimum space requirement is 9 m²/person, with average height 2,8 m (see Table C3)
- Health and comfort: determined by the aspects of lighting, airing, indoor temperature and humidity
- Security and Safety: concerning main building elements (foundation, walls and building frames, roof and floor)

CONCEPT OF THE HEALTHY MODEST HOUSE

A Healthy Modest House is a house which is built using modest building construction and materials, but still fulfils the minimum standard of health, safety and comfort requirements, with a consideration to local potentialities, both physical (i.e. building materials, geology and climate) and social-cultural (i.e. local architecture and lifestyles).

The majority of low-income people are still not able to afford Healthy Modest Houses, therefore the Indonesian government offers *Rumah Inti Tumbuh* (RIT), which functions as the main/basic part of a house and is expected to be expanded and grow into a Healthy Modest House whenever the owner can afford it. An RIT fulfils only the minimum requirements of a house:

- An RIT consists of the most modest space: a closed space (bedroom, 3x3 m²), an open roofed space (multi-purpose, 3x3 m²) and a sanitary facility (1,2x1, 5 m²)
- The design of the RIT roof anticipates expected changes: RIT provides a roof above an open space that functions as a multi-functional room
- The roof of the RIT can take various shapes (i.e. saddle, pyramid, cone) according to local or traditional requirements
- Natural airing and lighting of an RIT make use of openings that accommodate air circulation and sunlight.

Notes

1. *The guideline is accessible from the Public Works website as a downloadable document at www.pu.go.id/itjen/hukum/km403-02l1.pdf*
2. *Balitbang* = Badan penelitian dan pengembangan, *or research and development agency, Puskim* = Pusat Penelitian dan Pengembangan Permukiman, *or housing research and development center, Kimpraswil* = Permukiman dan prasarana wilayah, *or regional housing and infrastructure – a division of the Department of Public Works.*

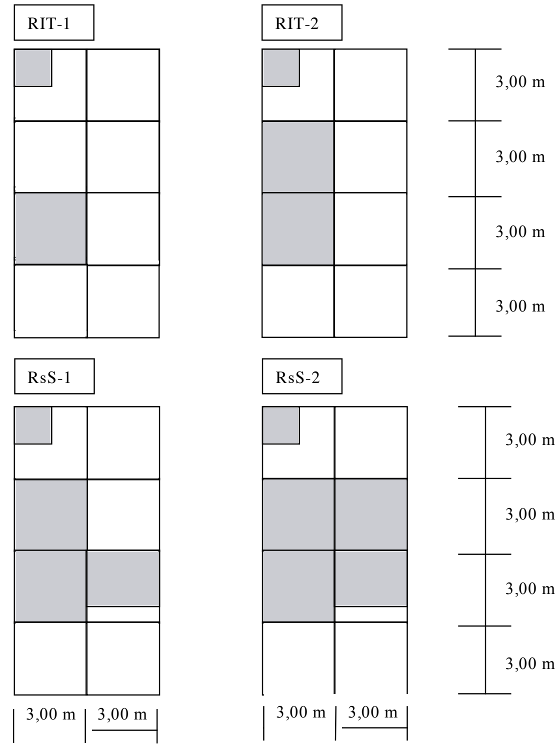

Fig. C.2: One of the proposed growing patterns: growing pattern of an RIT towards an RsS-2 (Healthy Modest Housing-2) on high-priced land, which forms row houses of minimum 6 m width, effective land width 72 m² and ideal land width 200 m².

APPENDIX D: Preservation of Bamboo (after Janssen, 2000 and Liese, 2003)

Being a biological material, bamboo, like wood, is vulnerable to factors such as fire and weathering and attacks from pests and microbes. These factors reduce the lifespan of bamboo products and are therefore a major challenge to bamboo's applicability. Similar to wood, it is possible to prevent these attacks to bamboo by preserving and protecting the material during storage, processing and use. Although prevention towards bamboo deterioration has been practiced for a long time, there is lack of information (knowledge about preservation possibilities, advantages and economics) concerning details of its implementation and lack of adequate treatment facilities and chemical preservatives. The cost of bamboo material may rise after being treated with the proper preservation method,[1] but in the long run it is more economical and it can lead to wider application. Growing concern about the consequences of applying safety regulations demand consideration of non-chemical possibilities, such as constructional methods, to keep the construction elements dry in order to prevent at least fungal decay.

Bamboo is different from timber in the following two aspects: sawn timber opens up numerous vessels and cells, which considerably eases the penetration of preservatives, and timber has rays that provide cross-connections between the vessels. Therefore, although adopting methods for wood, bamboo requires a different preservation treatment due to the way the plant is constructed. The outer skin of bamboo has a high silica content, which forms a perfect raincoat and resists insects, but also prevents preservatives from entering the culm. The internal side is covered with a waxy layer that is impermeable as well. The only entrance for preservatives is through conducting vessels, which cover less than 10% of the cross-section surface. These vessels close forever within 24 hours after harvest, which means that preservation has to be carried out within this very limited time span. Bamboo preservation methods fall into two categories: traditional and chemical.

TRADITIONAL

In areas where bamboo is indigenous, traditional preservation methods (i.e. curing, smoking, lime-washing and soaking and seasoning) are used. The real effect of these methods is not known, however, these methods are popular as they can be applied without any capital investment and with low skill levels.

- *Curing*: the harvested bamboo culms are left in the open, with branches and leaves intact. The transportation process, which continues after felling, causes the starch content to fall.
- *Smoking*: treatment of the culms over fire is effective against fungi and insects.
- *Lime-washing*: literally washing with lime water, is reported to protect against fungal attack.
- *Soaking and seasoning*: involves immersing the culms in stagnant or running water for a few weeks to leach out the sugars. After this, the wet bamboo stems are air-dried under shade.

CHEMICAL PRESERVATION

Chemical methods of preservation are compulsory when bamboo is to be used in mass industry or large-scale projects for housing or other buildings. Effective, inexpensive and safe chemicals are based on the element boron (i.e. boric acid, borax and boron). Chemicals such as arsenic are avoided as preservatives, due to the risks towards the environment and the health of those who handle them. Good preservation results have been obtained in Costa Rica with a boron-based fertilizer,

Fig. D1: Houses made of treated bamboo

Fig. D2: Houses made of untreated bamboo (photos by Jorge A. Gutiérrez). Preservation and maintenance of bamboo houses (D1) makes them last longer than those uncared for (D2) (Liese, 2003, pp. 179).

disodium octoborate tetrahydrate (chemical formula $Na_2B_8O_{13}.4H_2O$), with 66% active boron content. A big advantage of using this chemical is that it produces no waste: once it has been used in the preservation process for some time and mixed with starch and sugar from the bamboo itself, it can be applied as a fertilizer.

Two methods are available to introduce chemicals into the bamboo: the modified Boucherie process for whole green culms and dip-diffusion for split culms.

MODIFIED BOUCHERIE PROCESS

This method can be applied only to fresh bamboo, within 24 hours after harvesting. In this method, the preservative is passed under pressure through the culm vessels until it comes out at the other end of the culm. As the preservative is passed through the vessels, the remaining 90% of the cross-section does not get any contact with the preservative.

The preservative liquid is kept in a closed drum, which is connected to one end of the bamboo stem with rubber tubes and sleeves tightly clamped around the end of the stem. An air pump provides the pressure. Air in the upper part of the sleeve has to be removed; otherwise, the upper part of the culm will remain unpreserved, resulting in badly treated culms.

At first, sap will start dripping from the lower end without preservative in it. As the process continues, the concentration of preservative in the sap will increase. The process has to be continued until the whole length of bamboo gets a sufficient quantity of preservative. To determine the end of the process, the concentration of the solution dripping from the lower end must be checked. If it nearly equals the concentration of the preservative in the tank, the process is complete.[2] The liquid passing out of the culm may be re-used after cleaning and adding chemicals to achieve the original concentration. After treatment the culms must be stored under shade to dry.

An alternative Boucherie method is to scrap the inner wall surface of the bottom-most internode of the culm, then hang the culm vertically and fill the prepared internode with the preservative. Scraping the inner wall gives the preservative access to the culm wall tissue.

DIP DIFFUSION

This method can be applied only to split or sawn bamboo strips, since whole culms will not allow the preservative to penetrate. In this method, the culm is first immersed (or dipped) in the preservative so that a slow penetration process (diffusion) takes place.

Split bamboo pieces of the required size are immersed in a bath with the preservative solution, and weighed down with bricks to keep them immersed. After about 10 minutes of soaking, the bamboo pieces are taken out of the bath (gloves should be worn). Excess preservative is drained into the bath. The bamboo pieces are wrapped in plastic sheets and left for one week. Afterwards, the sheets are removed and the bamboo is seasoned in a vertical position for another week.

Treated bamboo should never be burned: the gases that emanate from them would be quite toxic. Should they be disposed off, they should be buried in the ground, at a safe distance from water bodies (e.g. in a pit latrine). The same disposal method applies to waste preservatives. The harm caused by the chemicals to the environment or to drinking water should not be taken lightly, therefore precautions should be conducted properly. A preservation process on an industrial basis, which requires close attention, includes proper training of staff, safety precautions, management, quality control and the economy of the process.

The economics of preservation are clear: the price of the bamboo increases by about 30%, but its service life increases to 15 years in the open and 25 years under cover. So a cost-benefit analysis will easily bear out the desirability of preservation.

Houses in D1 are at a different location from the ones in D2 (architect: Jorge Arcila), built in 1985 for Malabar project in Manizales, Colombia. These photographs were made in 2000, or after 15 years of the project, showing the difference between the houses that were built with treated bamboo (D1) and untreated bamboo (D2) (Gutierrez, 2000). It should be noted that durability depends firstly on good building details, then on maintenance and only in the last place on preservation.

Notes

3. *The term preservation generally refers to all measures to avoid material degradation. It is important to distinguish between the broader term protection, which embraces all means to protect bamboo, and the term preservation, which uses preservative chemicals as part of the protective measures (Liese, 2003, pp.10).*

4. *It commonly takes about 30 minutes for a length of three meters of Guadua spp. (based on Dr. Janssen's experience in Costa Rica).*

APPENDIX E

Bamboo as a Building Material

MECHANICAL PROPERTIES (AFTER JANSSEN, 2000)
The most important mechanical property of bamboo is the mass of the material per unit volume (or the density), commonly expressed in kg/m^3. For most bamboos, the density is about 700-800 kg/m^3, which varies according to the quality of the site of growing, the species, the position in the culm, etc. Why is this property important? The greater the mass per volume, the heavier the bamboo becomes, due to the amount of molecules that are present per unit volume. In other words, the greater the mass per volume, and denser the material – which is to be preferred in most situations. This relation between mass per volume and strength gives some rules of thumb. For instance, the bending stress at failure (in N/mm^2) can be estimated as being 0.14 times the mass per volume (in kg/m^3).

A notable feature is that 'failure' in bending of bamboo is not a failure. This can be explained as follows: if a bending test is performed on a beam of timber or any other building material, first a 'crack' develops and then the beam breaks into two pieces – a real failure. Bending tests, such as the long-term bending test shown in Fig. E1, were performed at the Technical University of Eindhoven from 1981 until 1988. Fig. E2 shows a bamboo stem after 'failure'. In bamboo, all fibers along its length still exist without any damage. The only thing that has happened is that the bond between the fibers has broken down and, consequently, the circular form of the cross-section has lost its strength. Remarkably, if the load is removed, the bamboo specimen will return to its original straight form. This phenomenon has great practical importance. If a bamboo house has suffered from a heavy earthquake, some bamboo elements in it might show some damage. But the house will still be standing and be habitable. Some temporary repair measures – such as winding a rope around the damaged bamboo – are all that would be required until the damaged posts or beams can eventually be replaced.

Compared to wood, bamboo is stronger in shear (Janssen, 2000). Fig. E3 shows a test on shear, performed in Costa Rica, according to a test method developed at the Technical University of Eindhoven in the 1970s. Shear is important in joints (using nails, bolts, pins and similar fasteners), which connect one bamboo stem to another. In all these joints, a hole is made in the stem, through where the fastener is inserted. When in use, a tensile force from this fastener will be applied towards the end of the bamboo joint, resulting in shear. The test method in Fig. E3 has been selected after a long series of comparisons among different test methods (and is also a good example of North-South technical co-operation).

USES OF BAMBOO (AFTER JANSSEN, 2000)
Bamboo can be put to thousands of uses, but most of the trade in bamboo articles happens on the informal market, so the annual value of the global trade in bamboo products is difficult to determine. However, a conservative estimate puts it at US$ 10 billion. Following is a brief discussion of some major uses of bamboo.

SCAFFOLDING
Bamboo scaffolding has a rich tradition in many Asian countries such as China, India and Thailand. Bamboo scaffolding is renowned for its capacity to resist hurricanes; it has survived hurricanes that

Fig. E1: Bending test, performed at the Technical University of Eindhoven (1981-1988).

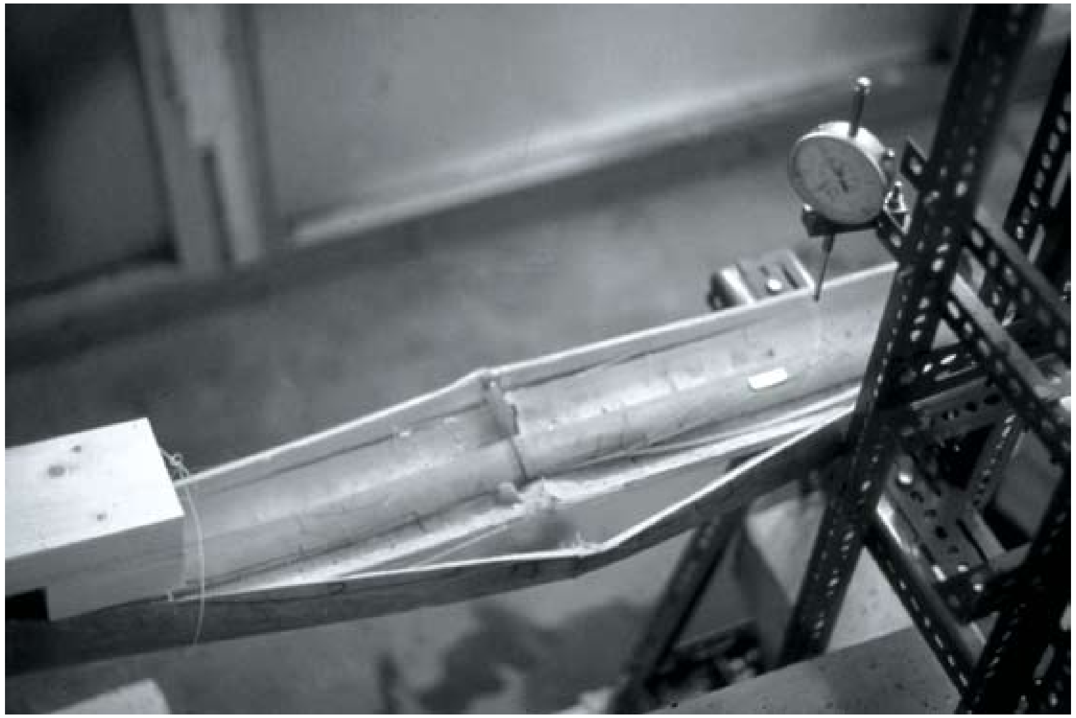

Fig. E2: Bamboo after a bending 'failure'.


Fig. E3: A test on shear, performed in Costa Rica, according to a test method developed at the Technical University of Eindhoven in the 1970s. Fig. E.4: A man working at a bamboo scaffolding of a high rise building in China (National Geographic, 1987)


Fig. E.5: One of the 1987 prototypes of the National Bamboo Project (NBP) in Costa Rica. Fig. E.6: A panel factory in Costa Rica.


Fig. E.7: A bamboo chair. Fig. E.8: A couple of bamboo handicraft souvenirs.

blew away steel ones as if they were matchsticks. However, bamboo scaffolding is now suffering from competition with steel scaffolding, due to the latter being an industrial product with standardized dimensions, which has the advantage of rapid (dis)assembling. In this respect, bamboo scaffolding needs technical upgrading, but the development towards this direction faces a number of obstacles. For instance, the (traditional) knowledge of setting up the scaffolding is circulated only among workers who are organized in guilds, who withhold this specific expertise to people who do not belong to certain families. This structure is a guarantee for traditional knowledge transfer, but a major obstacle for bringing in contemporary developments.

HOUSING

Bamboo is an excellent option for good and cheap housing. One of the 1987 prototypes of the National Bamboo Project (NBP) in Costa Rica (Fig. E4) is an example of a good design:[1] overhanging roof, a structure of bamboo culms, walls of panels of split bamboo with cement mortar on both sides, and ventilation through the upper part of the walls.

People's capacity to invent their own solutions for difficult problems plays an important part during the housing development project. An example of such a solution is: everybody knows that bamboo should not have any prolonged direct contact with the soil. But a bamboo column needs to be anchored securely to the foundation, in order to keep the house down during strong winds. To cope with this challenge, the NBP staff invented a prefabricated foundation: the bamboo column is extended at the lower end using concrete, which penetrates the bamboo for about 400 mm (the length of an internode) and extends outside the column for over 600 mm. The concrete is poured into the bamboo culm kept in upside-down position. A piece of PVC tube, cut lengthways and wrapped around the bamboo is being used as framework.[2] This solution is commendable because it is simple and effective.

If bamboo is considered for mass housing, then it is necessary to look into prefabrication options. Fig. E.6 shows a panel factory in Costa Rica. Imagine a situation where 1.200 houses have to be built annually, of which each needs 17 panels. This means that one panel has to be produced every six minutes, given an 8-hour shift per day and 250 working days. This situation demonstrates that bamboo, a material that is regarded as a rural commodity for the smaller farmer and his family – although this is true to a large extent – has an industrial side as well. More of such industrial processes need to be developed if bamboo is designated to contribute towards housing large quantities of people. It should also be kept in mind that industries provide large-scale employment, which is an economic necessity in most developing countries.

FURNITURE & OTHER CONSUMER PRODUCTS

The previous statement leads to the role of bamboo in job creation. Bamboo is a material that provides several job creation opportunities because many products can be made from it with low capital investments. The precondition for this is a social structure, mainly in villages, that fosters cooperatives, and education and training in making bamboo products.

Fig. E.7 shows a chair, an example of furniture that can be made at village level, with simple tools. This product represents not only bamboo's aesthetic value, but also its durability and, most importantly, its marketability value. In most cases, the last item is the bottleneck, because the chair can hardly compete with products that are made of other materials, i.e. wood, plastic and does not yet meet the quality, taste and price standards of the market in Europe or the United States. Unfortunately, it is a long strive for bamboo products to meet export requirements.

Fig. E.8 shows a simpler item: two pieces of handicraft for tourists. Souvenir products are a promising area, provided there are tourists around. In this case, a good design is essential as well, but the quality level can be lower (compared to export products), as tourists buy these items for their souvenir value, thereby with a less critical mind. For this kind of products, what needs to be pointed up is a sound cooperative system, which ensures that the profit does not remain in the shop in town, but reaches the people in the village who create the artefacts.

Comprehensive information concerning bamboo and its properties as a building material can be acquired from *Designing and Building with Bamboo* (Janssen, 2000). The subjects of bamboo products and the levels of technology used in the bamboo industry are discussed in *Uncovering the Green Gold of Indonesia* (Larasati, 1999).

BAMBOO BUILDING CODE

One billion people on the earth live in bamboo houses usually built without proper building standards. Bamboo has certain advantages over other construction materials such as concrete, bricks and timber. Bamboo houses are much safer during earthquakes, landslides and flooding. Despites its valuable qualities, professional architects normally hesitate to use bamboo for construction purposes simply because of the absence of proper Bamboo Building Codes. Loans and insurance are not available for bamboo constructions. Introduction of a bamboo building code will open up a wide construction market for bamboo and will promote development of bamboo industry, inspire new designs, technologies and expand architectural horizons.

The ideas of developing building standards for bamboo was developed during an INBAR workshop in India in 1988, followed by a 1995 meeting in Ubud. During the following year the work on building codes was implemented by a small group of volunteers headed by Dr. Jules J. A. Janssen. Very recently INBAR's Bamboo Building Draft International Standards (DIS 22156 and 22157) have been approved by the International Standard Organization and have been published as ISO 22156:2004 (E), ISO 22157-1:2004 (E) and ISO/TR 22157-2:(2004) E.

Notes

5. *A 'good design' means in this case that all requirements for an adequate house are being met at a reasonable cost.*

6. *There could have been a risk of cracking of the bamboo part that has a direct contact with the concrete. However, this did not happen in practice during the NBP project, possibly due to the Guadua species (which is used in this project), which' fibers cross one another. Therefore, it can be assumed that a higher risk of cracking is higher if other species, which' fibers run strictly parallel, is used.*

APPENDIX F: Process to acquire a building permit in Jakarta

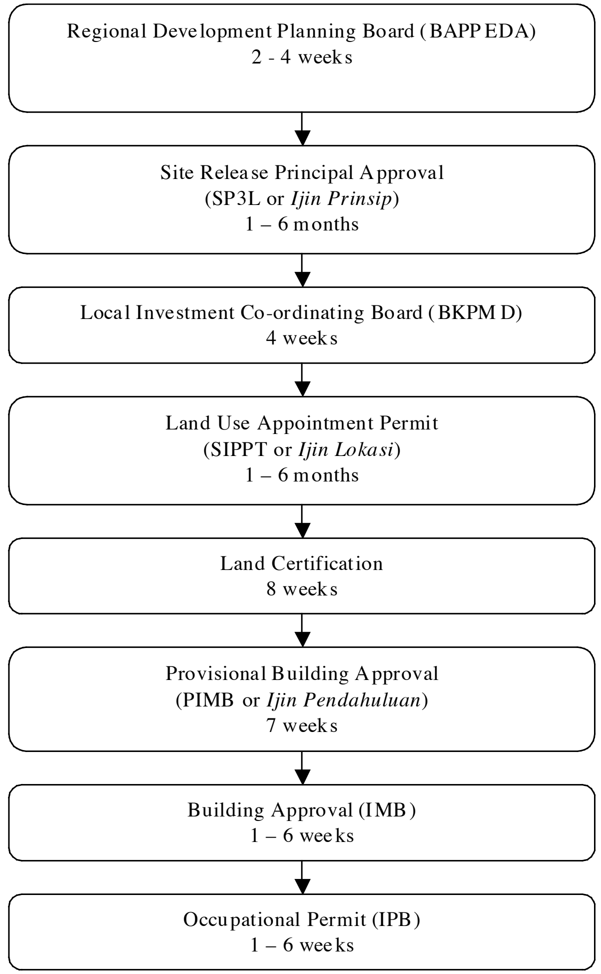

Fig. F1: Development Permit Procedure in Jakarta

BAPPEDA = *Badan Perencanaan Pembangunan Daerah*
SP3L = *Surat Persetujuan Prinsip Pembebasan Lokasi/Lahan*
BKPMD = *Badan Koordinasi Penanaman Modal Daerah*
SIPPT = *Surat Izin Penunjukan dan Penggunaan Tanah*
PIMB = *Permohonan Ijin Mendirikan Bangunan*
IMB = *Ijin Mendirikan Bangunan*
IPB = *Ijin Pengguna Bangunan*

APPENDIX G: Development permit procedure in Jakarta

Development Control System: in order to regulate land use and development, any person or company who wishes to develop or subdivide land must obtain certain permits from the authorities. The procedure for obtaining development permits in Indonesia can be slightly different from one administrative region to another.

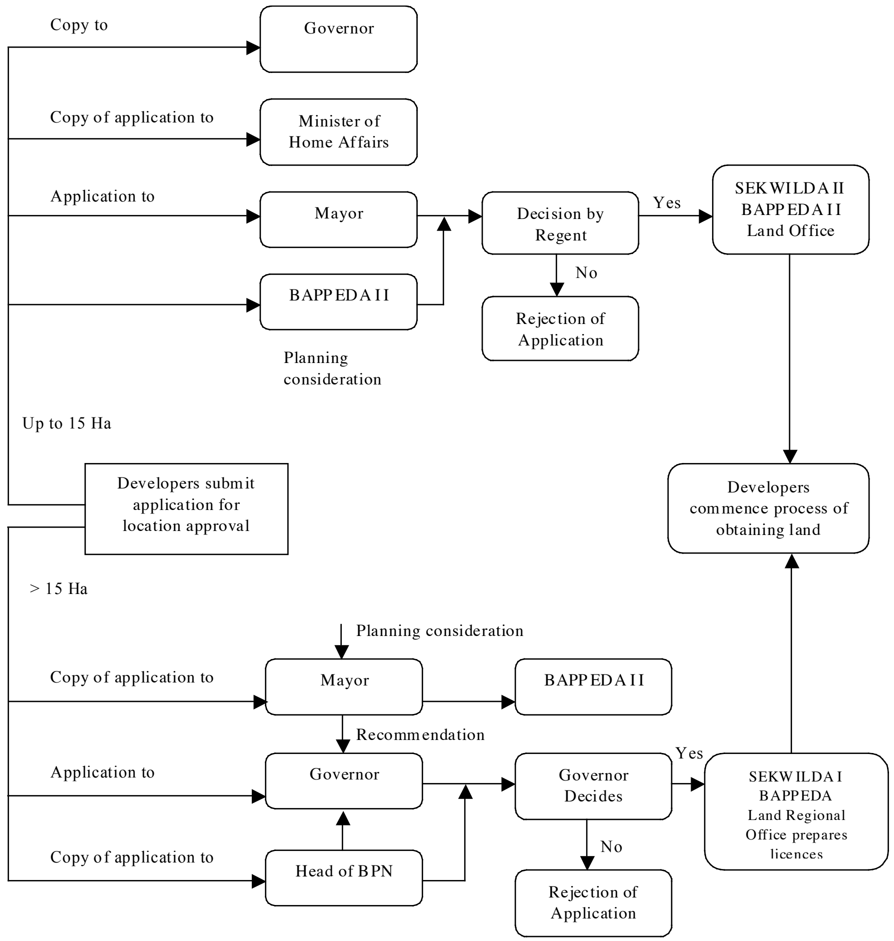

Fig. G1: Procedure for Applying Location Permit

SEKWILDA = *Sekretariat Wilayah Daerah*, or Regional Secretariat
BAPPEDA = *Badan Perencanaan Pembangunan Daerah*, or Regional Plan and Development Agency
BPN = *Badan Pertanahan Nasional*, or National Land Agency

APPENDIX H Policy and Program of Housing Subsidies for Low-Income People

People with informal income between 500.000 and 1.300.000 IDR can take the advantage of KPR scheme of housing industry, if they become or join a legal organization (co-operation, foundation, professional association).

Table H1: Policy and program of housing subsidies for low-income people in Indonesia (formal income).

AIMED GROUPS P = INCOME GROUP (INCOME IN IDR PER MONTH)	HOUSE TYPES	FACILITY/SUBSIDY PROGRAM	DEFINITION
PEOPLE WITH FORMAL INCOME			
P > 1.300.000	Owned/rented house	According to market mechanism (free)	No subsidy program
850.000 < P < 1.300.000	Owned house (housing industry)	KPR subsidy (RS 21 & 27) Credit insurance	KPR subsidy in the form of: 1) Interest difference 2) Down payment Rent subsidy in the form of: 1) Land: government property or industrial area or tukar guling 2) Construction: investment for construction using inexpensive funds (PMP, long-term soft loan) Rent subsidy (cheap): the amount of rent fee is adjusted to each group of income
	Rented house	Rent subsidy (cheap)	
500.000 < P < 850.000	Owned house (housing industry)	KPR subsidy (RSS 21 & 36) Credit insurance	
	Rented house	Rent subsidy (cheap)	
350.000 < P < 500.000	Rented house	Rent subsidy (house)	
	Owned house (self-effort)	- Rotating loans - PSD Perkim - Dispensation in land and IMB certification - Credit insurance - Improvement of environment quality - Building materials	

KPR = *Kredit Pemilikan Rumah*, or House Ownership Credit
RS = *Rumah Sederhana*, or Modest House (the numbers that follow are the types, corresponding to the floor width of the house)
RSS = *Rumah Sangat Sederhana*, or Very Modest House
IDR = Indonesian Rupiah
IMB = *Ijin Mendirikan Bangunan*, or Building Permit
PSD = *Prasarana dan Sarana Dasar*, or Basic Service and Facility
Perkim = *Permukiman*, or Housing
PMP = *Penyertaan Modal Pemerintah*, or Involvement of Government Capital
Tukar guling = *ruilslag* (Dutch) = swapping/interchange.

Table H.2: Policy and program of huising subsidies for low-income groups in Indonesia (informal income)

AIMED GROUPS P = INCOME GROUP (INCOME IN IDR PER MONTH)	HOUSE TYPES	FACILITY/SUBSIDY PROGRAM	DEFINITION
PEOPLE WITH INFORMAL INCOME			
P > 1.300.000	Owned/rented house	According to market mechanism (free)	No subsidy program
850.000 < P < 1.300.000	Owned house (self-effort)	- Rotating loans - PSD Perkim - Dispensation in land and IMB certification - Credit insurance	
	Rented house	Rent subsidy (cheap)	
500.000 < P < 850.000	Owned house (self-effort)	- Rotating loans - PSD Perkim - Dispensation in land and IMB certification - Credit insurance	
	Rented house*	Rent subsidy (cheap)	
350.000 < P < 500.000	Rented house*	Rent subsidy (house)	
	Owned house (self-effort)	- Rotating loans - PSD Perkim - Dispensation in land and IMB certification - Credit Insurance - Improvement of environmental quality - Building materials	* Type of rented house provision uses the same rented house scheme as for the formal income groups
P < 350.000	Rented house*	Rent subsidy (house)	
	Owned house (self-effort)	- Rotating loans - PSD Perkim - Dispensation in land and IMB certification - Credit insurance - Improvement of environmental quality - Building materials - Economic reinforcement	

Source: http://www.pu.go.id/Ditjen_mukim/KPR/masy_rdh.htm

APPENDIX I

Usability Tests of the DCBA booklet

SCOPE

Due to time and geographical constraints, the usability tests of the booklet could not be conducted in a real housing development project in Indonesia. In the first test, a draft version of the booklet was used as a simulation of a discussion by a group of students in Delft. Their input was used to modify the draft into a second version, which was used the next day in the second test, in Amsterdam. The finished version of the booklet (which accompanies this dissertation) is the outcome from these discussion sessions.

OBJECTIVES

The tests aimed to investigate the usability of the booklet: whether it can be used as a convenient discussion tool by common people. The tests were also conducted in order to gain opinions and input concerning the format and contents of the booklet, which were used to complete the final prototype of the booklet.

PARTICIPANTS

Since this booklet is aimed mainly for the situation in Indonesia, Indonesian students were chosen to be participants in the tests, considering their familiarity with not only housing conditions in Indonesia but also with relevant factors such as politics and culture. It was of great benefit to have some students available who had first-hand experience with working in post-disaster areas or with living in an ecological village in Indonesia. However, a usability test whose participants are experts in the field of housing is still necessary to improve the contents of the booklet.

TEST 1: DELFT

Place: Roland Holstlaan, Delft
Time: Saturday 9 September 2006, 09:00 – 12:00 (while having breakfast)

PARTICIPANTS

Indonesian Master students of TU Delft:

- Melati Kusumawardhani (25/F), Industrial Design Engineering
- Sigit Kusumawijaya (24/M), Urbanism
- Edwin Husni Sutanudjaja (25/M), Water Management, Civil Engineering
- Tigor Hamonangan (26/M), Petroleum Engineering
- Andrew Ivan Julius Sitorus (24/M), Reservoir Geology
- Gitasanti Andriani (24/F), Urbanism

METHOD

- The students were asked to play a role as representatives of a village community (heads of the village, youth club, women activist, etc.)
- The scenario for the village is as follows: it is a *kampung* (village) located in a sub urban area, next to a rapidly developing urban area. The development reaches this *kampung* as well, therefore there is a plan to improve the housing conditions of this *kampung*. The *kampung* inhabitants will use the booklet to discuss their wishes and demands among themselves, to communicate the results

Fig. I.1: Test 1 in Delft

to the developers, architects, policy makers or investors and to have control among their own commitments towards their neighbourhood.

PROCESS

- An introductory explanation was given to the students
- A student who acted as the village chef took the role of moderator leading the discussion
- The discussion went from one theme to another, starting with the ones most interesting for the group. Edwin: 'Let's talk about money matters first. That's what most people are worried about concerning their housing'.
- There was a break during the session
- The session ended after all themes were discussed

SUMMARY OF INPUT DURING DISCUSSION

1 Each theme still needed oral explanation. A number of illustrations could not precisely represent the contents:
- Mel: 'The illustrations really help making the choice. But perhaps you should make the wording more simple and the graphics more recognizable.'

2 Themes that were not completed yet were skipped, although also being discussed informally.
- Edwin: 'Is it cultural aspect that compromises the choice of material quality? A community I used to work with was given a sum of money to build high-quality housing. However, they preferred building low-quality housing – and keeping the rest of the money – to building according to plan.'

3 A number of topics managed to rouse extensive discussions before reaching decisions, for example in the theme of Material Resources:
- Andrew: 'I'm not going to go through too much trouble buying my building materials. I'll choose the more sustainable options only when they're available nearby and at reasonable prices. Otherwise, it will be too expensive and troublesome'

Or in the theme of Water Source:
- Edwin: 'An NGO has provided a communal drink water pipe in a post-disaster area, so people can have clean water for free. However, the inhabitants became careless and left the pipe open, letting the water running to waste. The NGO solved this problem by tightening the drainage, which reduces the water flow drastically, so these people can no longer abuse it. They have to stand in line, waiting for the dripping water to fill their buckets.'

Other topics could be treated with prompt agreement, for example in the theme of Certifications:
- Santi: 'But of course everyone will choose to have complete and valid certificates. This is too obvious.'

4 The discussion was sometimes interrupted by conversations about the scenario, in order to be able to reach a reasonable decision from the D, C, B, or A options:
- Mel: 'What's it to the architect or developer if we choose one option or another?'
- Edwin: 'This booklet is a good communication tool among the inhabitants. But how can the inhabitants make sure that they get what they want (according to the booklet) from the developer?'
- Sigit: 'It is necessary to prepare a detailed and thorough scenario, such as demographic data of the *kampung*, if justifiable results are to be achieved.'

CONCLUSIONS AND CHANGES IN THE BOOKLET MADE BASED ON THIS TEST

1 Texts and images: terms and wordings in the introductory part and theme contents in the booklet were simplified. Illustrations, which should help explaining the options, were completed and improved to be more recognizable.

2 Expenses control during project: it is necessary to have a supervising agency that is trusted and respected by the local people (perhaps by including representatives of the community in the agency). This point is recommended as an additional theme for the booklet.

3 Availability and supply of materials: people tend to choose the most practical and inexpensive options; they do not consider sustainability as a priority. It is the responsibility of ecologically-conscious material distributors and suppliers to provide accessible sustainable options. In a real situation, local material suppliers should be mentioned within the options of the booklet.

4 Complimentary communal facilities: it should be noted that people display a lack of sense of belonging towards 'free' public properties. A solution is a training session for operating and maintaining the facilities; another is adjusting the facilities to the habits of the inhabitants. However, the best solution is involving the inhabitants themselves in providing these facilities. In a real situation, the booklet should include references to manuals of operation and maintenance of the facilities.

5 Obvious options for the theme Certifications: in the booklet, the options are changed into levels of complication in acquiring the certificates.

6 General remarks for the booklet: it should be able to be a tool for the inhabitants to communicate their wishes to the developer. It should also be a control tool during the development process, with which the inhabitants can check if the project is conducted according to plan or can make adjustments during the process. Some themes have consequences for the architects and developers in the design of the housing, some to the inhabitants and their own commitments.

Fig. I.1: Test 2 in Amsterdam

TEST 2: AMSTERDAM

Place: 2e Jacob van Campenstraat, Amsterdam
Time: Sunday 10 September 2006, 13:00 – 16:00 (while having lunch)

PARTICIPANTS

Indonesian students of InHolland Hogeschool
- Dian Apradika Kusumawati (21/F)
- Primata Tantiana (21/F)
- Bulan Mendota (21/F)

METHOD

Similar to the method used in Delft

PROCESS

- An introductory explanation was given to the students
- Since there were only three participants, they all acted as the village representatives
- The discussion went from one theme to another in order (from the first to the last theme)
- There was a break during the session
- The session ended after all the themes were discussed

SUMMARY OF INPUT DURING DISCUSSION

1. Hardly any guidance was provided during the discussion (on purpose); however, the booklet still needed explanation at some parts where terms specific to housing development contexts are used:
- Bulan: 'The texts are easy to understand, but some specific housing terms should be changed into more general terms.'

2 The discussion went on fluently; only sometimes the group got confused whether they should choose their current situation, or a situation that they wish would have for their future housing:
- Tanti: 'The introductory part should be made clearer. Perhaps just give one plain command there, such as, *choose the situation you prefer*.'

3 Discussion of some themes required extra time to redefine playroles, often when the group represented wealthy *kampung* residents or low-income housing inhabitants:
- Dika: 'There should be a clearer characteristic of this discussion group. In making the choice, one of the first things that comes to mind is our financial capability.'

CONCLUSIONS AND CHANGES IN THE BOOKLET MADE BASED ON THIS TEST

- Text: in the Introduction part, the texts concerning the steps (of how to use the booklet) are simplified and technical terms in the text are rephrased into daily language style (for example, *economy* to *money matters*, *social-cultural* to *people*, *adequate space width* to *space* and *surrounding environment* to *outside*).

- The discussion group could use the booklet with little explanation. The problem in this simulation was mainly solved by choosing a scenario from an existing *kampung* that is familiar for all participants, to which they can refer to in playing their roles. In a real situation, this problem should be solved by having thorough financial data from all the participating inhabitants.

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ACRONYMS AND GLOSSARY

Bakosurtanal = *Badan Koordinasi Survei dan Pemetaan Nasional*, or Coordinating Body for Survey and National Charting Development Board
BAPPEDA = *Badan Perencanaan Pembangunan Daerah*, or Regional Plan and Development Agency
BKPMD = *Badan Koordinasi Penanaman Modal Daerah*
BKPN = *Badan Kebijakan Perumahan Nasional*, or Agency for National Housing Policy
BPN = *Badan Pertanahan Nasional*, or National Land Agency
BPPT = *Badan Pengkajian dan Penerapan Teknologi*, or Agency for the Assessment and Application of Technology
BPS = *Badan Pusat Statistik,* or Central Bureau of Statistics
BRR = *Badan Rekonstruksi dan Rehabilitasi Aceh-Nias,* or Reconstruction Agency for Aceh and Nias
BTN = *Bank Tabungan Negara,* or State Savings Bank
DCBA = A method to compare ecological performance of products and services. The D variant represents the situation in which no more attention is paid to the environment, other than required by law. The A variant is best for the environment; levels C and B are a small and a large step forward, respectively.
EBF = Environmental Bamboo Foundation
FAO = Food and Agriculture Organization
Gotong royong = voluntary communal activity
ICSID = International Counsil and Society of Industrial Design
IDR = *Indonesian Rupiah*, Indonesian currency
IDSA = Industrial Design Society of America
IHBC = Institute of Historic Building Conservation (United Kingdom)
IMB = *Ijin Mendirikan Bangunan,* or Building Permit
IPB = *Ijin Pengguna Bangunan*, or Building Occupation Permit
ITS = *Institut Teknologi Sepuluh Nopember*, or 'Ten November' Institute of Technology in Surabaya, East Java
KIP = Kampung Improvement Program
KM = *Koordinasi Modular,* or Modular Coordination, a standardized measurement for building materials
KPKSB = *Kredit Pemilikan Kapling Siap Bangun,* or land ownership credit
KPR = *Kredit Pemilikan Rumah,* or Public Housing Credit, or housing loan
KOPENAS = *Koperasi Permukiman Nasional,* or the National Housing Co-operation
LIPI = *Lembaga Ilmu Pengetahuan Indonesia,* or the Indonesian Science Institute
NCIV = *Het Nederlands Centrum voor Inheemse Volken* or The Netherlands Centre for Indigenous Peoples
NWR = *Nationale Woningraad* or The National Housing Council. In 1998, NWR & NCIV fused into Aedes Vereniging van Woningcorporaties, a national organisation promoting the interests of practically every social housing organisation in the Netherlands
Perkim = *Permukiman,* or housing
Perum Perumnas = *Perusahaan Umum Perumahan Nasional,* or National Urban Development Corporation
PIMB = *Permohonan Ijin Mendirikan Bangunan*
PLN = *Perusahaan Listrik Negara,* or State Electricity Company
PPLH Seloliman = *Pusat Pendidikan Lingkungan Hidup* or Envrionement Education Center in Seloliman, East Java
PMP = *Penyertaan Modal Pemerintah,* or Involvement of Government Capital
PSD = *Prasarana dan Sarana Dasar,* or Basic Service and Facility
Puslitbang Permukiman = *Pusat Penelitian dan Pembangunan Permukiman,* or Housing Research and Development Center
RIT = *Rumah Inti Tumbuh,* or the basic part of a house which is expected to grow into an RsS (see below)
RS = *Rumah Sederhana,* or Modest House
RSS = *Rumah Sangat Sederhana,* or Very Modest House
RsS = *Rumah Sederhana Sehat,* or Healthy Modest House
SEKWILDA = *Sekretariat Wilayah Daerah,* or Regional Secretariat
SIPPT = *Surat Izin Penunjukan dan Penggunaan Tanah,* or Land Use Permit
SME = Small- and Medium-sized Enterprises
SP3L = *Surat Persetujuan Prinsip Pembebasan Lokasi/Lahan,* or Letter of Approval for Land Release
TPK = *Tim Pembangun Kampung,* or village development team
Tukar guling (or ruilslag) = swapping
UNDP = United Nation Development Program
UNEP = United Nation Environmental Program
VNG = *Vereniging van Nederlandse Gemeenten* or Association of Dutch Municipalities

SUMMARY

Towards An Integral Approach of Sustainable Housing in Indonesia. With An Analysis of Current Practices in Java

DWINITA LARASATI

Chapter 1 starts with describing the background of the research. Pressure on the environment caused by the increasing world population is evident especially in dense urban areas of developing countries, such as Jakarta, Bandung and Surabaya in Indonesia. Among the most acute environmental problems in Indonesia are air pollution, clean water provision and household waste disposal. Inconsiderate domestic habits, and lack of constructive communication among actors in housing projects cause environmental damage and unappealing (and therefore improperly used or even unused) facilities. Housing occupants feel left out during the planning and development of the project, while the developers consider the inhabitants to be too demanding.

The time has come to endorse an integrated way of thinking towards housing in order to improve present environmental conditions. Active participation of the local community in housing projects is crucial. Therefore it is advisable to:

- acknowledge skills and capacities of the local community
- attempt to discover local solutions
- make use of local materials and resources as much as possible
- stimulate community involvement and a feeling of 'ownership'
- allow community participation

The objectives of the research are to:

- define sustainable housing for Indonesian conditions
- determine the current level of sustainable housing implementation in Indonesia
- look into an example of an Indonesian indigenous natural resource which can serve as an element for sustainable housing (bamboo)
- produce a communication tool which can help rouse interest of inhabitants to be actively involved in improving their own domestic environment

The main research question is: 'How can the concept of sustainable housing be implemented in Indonesia?' This is broken down into three seperate sub-questions:

- What constitutes sustainable housing in Indonesia?
- How can the level of sustainable housing be determined?
- How sustainable is bamboo as a building material in Indonesia?

The main direction of the research – emphasis on using local resources and creating self-help communities – is supported by the philosophies of, among others, E.F. Schumacher and Ivan Illich, who both stressed that it is essential for people to develop their own domestic environment. Housing should not merely be seen as a product or a tangible entity, but also as an activity and a process towards a desirable lifestyle of a community.

In Chapter 2 definitions and parameters are given that can be used to qualify sustainable building. A general definiton is derived from existing surveys of sustainable building: 'Sustainable building results in buildings that are designed and constructed with high ecological standards (especially in minimizing waste and negative environmental impacts, and efficient use of energy, water and material resources), that are within the economic means of the occupants and promote their well-being.' For the purpose of this research, seven aspects of sustainability are distinguished, which were used to analyze current examples of sustainable housing implementation in Indonesia. This was done using the DCBA method, which provides four ambition levels of sustainability (gradually augmenting from D to A). This method is easy to comprehend and can therefore be an effective communication tool for actively involving prospective inhabitants during the planning and building process.

In Chapter 3 housing conditions in Indonesia are discussed, stressing that regional governments face difficulties in predicting the increase and decrease of population numbers, and as a consequence cannot provide an adequate amount of housing facilities. Another noteable point is the reluctance of governments to recognize indigenous *kampungs* as formal administrative parts of the city, which gives them the status of illegal settlements. These are subject to forced eviction and demolition, and as a consequence the living facilities remain sub-standard. Efforts such as govermental improvement programs have been conducted to cope with this situation, with varying degrees of success. Another possibility is to employ self-help, which mobilizes the occupants to improve their own domestic environment. This corresponds with the Indonesian *gotong royong* tradition (voluntary communal activities). *Gotong royong* can contribute to achieving a sustainable housing practice in Indonesia, providing a number of specific conditions are met.

Chapter 4 presents the analysis of five sustainable housing projects in Indonesia:
- the Healthy Housing Campaign of the government
- the *Kampung* Improvement Program (KIP) of the government
- the Eco-house built by *Sepuluh Nopember Institute of Technology* (ITS), Surabaya, for research aimed at passive-cooling technology application
- a mountain resort built by *Pusat Penelitian Lingkungan Hidup* (PPLH) in Seloliman, East-Java
- the self-supportive environmental improvement of Banjarsari Village in Cilandak, Jakarta

The three main conclusions that can be drawn from the analysis of these examples are:
- the application of the concept of sustainability in the field of housing can effectively improve the quality of environmental conditions
- the involvement of the inhabitants in their own housing project is proven to be effective in guaranteeing the maintenance of their domestic environment
- decisions that are made locally and motivation and initiatives from the basic level of society (family, neighborhood) provide the best sustainable housing solutions

Chapter 5 deals with the first research question: 'What constitutes sustainable housing in Indonesia?' As an elaboration of the answer to this question, a set of requirements is presented, which proposes a list of minimum necessities that should be provided in order to achieve sustainable housing conditions in Indonesia.

Also the second research question is answered: 'How can the levels of sustainable housing be determined?' This can be done by referring to the DCBA guideline for sustainable housing in Indonesia, which was developed using the previously mentioned set of requirements. This guideline was used to qualify the projects from Chapter 4. The DCBA scores from each of the actors show the following tendencies:

- both government programs score high in infrastructure and supply of electricity and water, because governments are capable of providing the means (policy, grids, regulations, enforcement, etc.)
- the NGO resort in East-Java scores high on the aspects of indoor and surrounding environment, because they have the advantage of a rural location and their buildings are not tied to city regulations
- the academic institution in Surabaya scores high on technical issues, because their experimental research is mainly focused on testing technical solutions
- the self-initiated activities in Banjarsari score high on social-cultural aspects, because the initiative itself already shows that there is a functioning community which is willing to develop itself towards a more sustainable lifestyle.

As a supplement with this dissertation an illustrated booklet was produced, which is a protoype of a guideline for sustainable housing in Indonesia, set up according to the DCBA method. It is meant as a communication tool for housing occupants, to help them discuss their demands and wishes among themselves and with the architects or developers. The booklet was evaluated through two usability tests.

The theoretical part of the research is followed by a more practical part in Chapter 6, which applies the theory of the previous chapters to one of the sustainable housing themes (material); specifically, it looks at bamboo as a promising option for an alternative building material for sustainable housing in Indonesia. Examples of bamboo housing are analysed, using the seven sustainable building aspects and the DCBA guideline, in order to qualify their sustainability levels. At the end of this section the third research question is answered: 'How sustainable is bamboo as a building material in Indonesia?' Bamboo as a building material can reach high scores in all sustainability aspects under certain conditions, but is virtually impossible to reach the highest scores for all. Therefore strategies are proposed to score as high as possible for all aspects, while taking the specific conditions in Indonesia into consideration.

Chapter 7 contains recommendations for future use of bamboo as a building material in Indonesia. Furthermore this chapter proposes the formulation of national bamboo standards for Indonesia, based on the international ISO standards for bamboo, as well as quantitative research to measure the sustainability values of bamboo construction more precisely.

Chapter 8 gives the answer to the main research question: 'How can the concept of sustainable housing be implemented in Indonesia?'. This can be done by recognizing and strategically employing a number of specific potentials of Indonesia that are relevant to sustainable housing. The concluding part is followed by recommended strategies towards sustainable housing for different actors in housing projects. As a closing remark it is emphasized that the bottom-up approach, as exemplified by for instance self-initiated housing projects, is one of the most important factors to achieve sustainability in Indonesia.

SAMENVATTING

Naar een integrale benadering van duurzame woningbouw in Indonesië. Met een analyse van huidige praktijkvoorbeelden op Java

DWINITA LARASATI

Hoofdstuk 1 start met de beschrijving van de achtergrond van het onderzoek. De druk op het milieu die wordt veroorzaakt door de aanhoudende groei van de wereldbevolking is vooral zichtbaar in dichte stedelijke gebieden van ontwikkelingslanden, zoals Jakarta, Bandung en Surabaya in Indonesië. De meest nijpende milieuproblemen die hiermee samenhangen zijn luchtvervuiling, schoonwatervoorziening en de verwerking van huishoudelijk afval. Ondoordachte huiselijke gewoontes en een gebrek aan constructieve communicatie tussen de betrokkenen bij woningbouwprojecten leiden tot schade aan het milieu en onaantrekkelijke (en daardoor verkeerd gebruikte en zelfs ongebruikte) woonvoorzieningen. Bewoners voelen zich buitengesloten tijdens de planning en de ontwikkeling van een project, terwijl ontwikkelaars de bewoners te veeleisend vinden.

Het is tijd voor een geïntegreerde benadering van de woningbouw om verbetering te brengen in de huidige omstandigheden. Actieve deelname van de lokale gemeenschap is bij woningbouwprojecten van essentieel belang, daarom is het raadzaam om:

- de vaardigheden en capaciteiten van de lokale gemeenschap te erkennen
- lokale oplossingen proberen te vinden
- zo veel mogelijk gebruik te maken van lokale materialen en hulpbronnen
- de betrokkenheid en een gevoel van 'eigenaarschap' bij de lokale gemeenschap te bevorderen
- gemeenschapsparticipatie toe te staan

In het tweede deel van hoofdstuk 1 worden de doelstellingen van het onderzoek geformuleerd:

- het bepalen van de voorwaarden voor duurzame woningbouw in Indonesië
- het vaststellen van het niveau van de huidige implementatie van duurzame woningbouw in Indonesië
- het nader bestuderen van bamboe als voorbeeld van een inheems Indonesisch bouwmateriaal dat als element voor duurzame woningbouw kan dienen
- het creëren van een communicatiehulpmiddel dat kan helpen inwoners actief te betrekken bij het verbeteren van hun eigen woonmilieu

De hoofdonderzoeksvraag luidt: 'Hoe kan duurzame woningbouw in Indonesië worden geïmplementeerd?' Deze vraag is opgesplitst in drie subvragen:

- Wat is duurzame woningbouw in Indonesië?
- Hoe kan het niveau van duurzame woningbouw worden bepaald?
- Hoe duurzaam is bamboe als bouwmateriaal in Indonesië?

De belangrijkste uitgangspunten van dit onderzoek – nadruk op het gebruik van lokale hulpbronnen en het opzetten van zelfhulpgemeenschappen – worden ondersteund door de filosofieën van onder anderen E.F. Schumacher en Ivan Illich, die er beiden op gewezen hebben dat het ontwikkelen van zijn eigen omgeving voor de mens een wezenlijke bezigheid is. Woningbouw moet niet slechts gezien worden als eindproduct of tastbare entiteit, maar ook als een activiteit en een proces dat gericht is op de gewenste levensstijl van een gemeenschap.

Hoofdstuk 2 geeft definities en parameters die kunnen worden toegepast om de duurzaamheid van het bouwproces te kwalificeren. Eerst wordt een algemene definitie afgeleid uit bestaande analyses waarin aspecten onderscheiden worden die van invloed zijn op de duurzaamheid van het bouwproces: 'Duurzaam bouwen is het ontwerpen van gebouwen met strenge ecologische normen (vooral wat betreft het minimaliseren van afval en negatieve milieueffecten, en efficiënt gebruik van energie, water en materiaal), die zich binnen het economische bereik van de bewoners bevinden en hun welzijn bevorderen.' Voor het doel van dit onderzoek worden zeven aspecten van duurzaamheid onderscheiden, die tijdens het onderzoek gebruikt zijn om de bestaande implementatie van duurzame woningbouw in Indonesië te analyseren.

Vervolgens wordt de DCBA-methode geïntroduceerd, een 'tool' dat tijdens het onderzoek is gebruikt om bestaande voorbeelden van duurzame woningbouw in Indonesië te kwalificeren. Deze methode reikt vier ambitieniveaus aan voor de bevordering van duurzaamheid (geleidelijk toenemend van D naar A). Voor deze methode is gekozen omdat hij voor iedereen gemakkelijk te begrijpen is en daarom een geschikt communicatiemiddel kan zijn om potentiële bewoners actief te betrekken tijdens de ontwikkeling en de uitvoering van een woningbouwproject.

In hoofdstuk 3 worden de voorwaarden voor woningbouw in Indonesië besproken. Regionale overheden hebben te kampen met moeilijkheden bij het voorspellen van de toe- of afname van bevolkingsaantallen en daardoor is het lastig vast te stellen hoeveel woningen nodig zijn. Een ander belangrijk punt is de terughoudendheid van overheden om inheemse kampungs als formeel administratief onderdeel van de stad te erkennen, waardoor ze de status van illegale nederzetting krijgen. Deze worden voortdurend bedreigd door uitzetting en sloop, met als gevolg dat de woonvoorzieningen beneden de maat blijven. Verbeteringsprogramma's van overheidswege zijn met wisselend succes ingezet om in deze situatie verbetering te brengen. Een alternatieve aanpak is de bewoners te mobiliseren om hun eigen omgeving te verbeteren. Dit sluit aan bij de Indonesische *gotong royong*-traditie van vrijwillige activiteiten ten behoeve van de gemeenschap. *Gotong royong* kan een bijdrage leveren aan het bereiken van duurzame woonomstandigheden, mits aan een aantal voorwaarden is voldaan.

Hoofdstuk 4 bevat analyses van enkele duurzame woningbouwprojecten in Indonesië aan de hand van de zeven eerder geformuleerde aspecten voor duurzaam bouwen in Indonesië. Het gaat om de volgende projecten:

- de *Rumah Sehat* (Gezond Huis) campagne van de Indonesische overheid
- het *Kampung Improvement Program* (KIP) van de Indonesische overheid
- het eco-huis van het *Institut Teknologi Sepuluh Nopember* (ITS) in Surabaya, dat gericht is op onderzoek naar de toepassing van 'passive-cooling technology'
- het verblijfsoord van het milieueducatiecentrum van *Pusat Penelitian Lingkungan Hidup* (PPLH) in Seloliman, Oost-Java
- de door de lokale gemeenschap zelf geïnitieerde milieuverbeteringsactiviteiten in het dorp Banjarsari in Cilandak, Jakarta

Uit de analyse van deze voorbeelden komen drie punten naar voren:

- dat het toepassen van duurzaamheidsconcepten op het gebied van woningbouw de kwaliteit van de milieuomstandigheden effectief kan verbeteren
- dat betrokkenheid van de inwoners bij hun eigen woningbouwproject een effectief middel is om het onderhoud van hun woonomgeving te waarborgen
- dat besluiten die lokaal worden genomen en initiatieven en motivatie op het basisniveau van de maatschappij (familie, buurt) de beste duurzame woningbouwoplossingen opleveren

Hoofdstuk 5 gaat in op de eerste onderzoeksvraag: 'Wat is duurzame woningbouw in Indonesië?' Een lijst met minimumvereisten vormt het antwoord op deze vraag. Vervolgens wordt tevens de tweede onderzoeksvraag beantwoord: 'Hoe kan het duurzaamheidsniveau van woningbouw worden bepaald?' Hiertoe is een DCBA-richtlijn voor duurzame woningbouw in Indonesië opgesteld aan de hand van de eerder genoemde minimumvereisten. Deze richtlijn geeft conform de DCBA-methode vier ambitieniveaus aan, waarmee het duurzaamheidsniveau van woningbouwprojecten gekwalificeerd kan worden aan de hand van een aantal thema's die tijdens dergelijke projecten een rol spelen.

Deze richtlijn is gebruikt om de voorbeelden uit hoofdstuk 4 te kwalificeren. Hieruit bleek dat:

- de twee overheidsprogramma's hoog scoren op het gebied van infrastructuur en elektriciteits- en watervoorziening, omdat overheden kunnen beschikken over de hiertoe benodigde middelen (netwerken, beleid, regulering, etc.)
- het NGO verblijfsoord op Oost-Java hoog scoort op het gebied van de binnen- en buitenruimte omdat men beschikt over een landelijk gelegen lokatie en de gebouwen niet gebonden zijn aan stedelijke verordeningen
- de academische instelling in Surabaya hoog scoort op technisch gebied, omdat hun experimentele onderzoek met name gericht is op het testen van technische oplossingen
- de zelfgeïnitieerde activiteiten in Banjarsari hoog scoren op sociaal-cultureel gebied, omdat al uit het initiatief zelf blijkt dat er een functionerende gemeenschap is die bereid is een duurzame levensstijl te ontwikkelen

Aan dit proefschrift werd als bijlage de 'Guideline for Sustainable Housing in Indonesia Using the DCBA-Method' toegevoegd. Dit is een prototype voor een communicatiehulpmiddel om bewoners in staat te stellen hun eisen en wensen onderling en met architecten en ontwikkelaars te bediscussiëren. Een conceptversie werd getest in twee gebruiksonderzoeken.

Het theoretische gedeelte van het onderzoek wordt in hoofdstuk 6 gevolgd door een praktisch gedeelte, dat de theorie (de reeks vereisten en de DCBA-richtlijn) op één van de thema's van duurzaam bouwen toepast (materiaal); specifiek wordt ingegaan op bamboe als een veelbelovend alternatief bouwmateriaal. Voorbeelden van woningbouw waarin bamboe is toegepast worden geanalyseerd aan de hand van de zeven aspecten voor duurzaam bouwen en de DCBA-richtlijn. Aan het eind van dit gedeelte wordt de derde onderzoeksvraag beantwoord: 'Hoe duurzaam is bamboe als bouwmateriaal in Indonesië?' Bamboe als bouwmateriaal kan onder bepaalde omstandigheden hoge scores behalen, maar het is vrijwel onmogelijk op alle punten de hoogste score te bereiken. Daarom worden strategieën aangereikt om zo hoog mogelijke scores te bereiken voor alle aspecten, rekening houdend met de omstandigheden in Indonesië.

In hoofdstuk 7 worden aanbevelingen gedaan voor toekomstig gebruik van bamboe als bouwmateriaal in Indonesië. Verder wordt het voorstel gedaan een nationale Indonesische bamboenormering te formuleren, gebaseerd op de internationale (ISO) bamboenormering worden. Een andere aanbeveling is meer gedetailleerd kwantitatief onderzoek te verrichten naar de duurzaamheid van bouwen met bamboe.

In hoofdstuk 8 wordt de hoofdonderzoeksvraag beantwoord: 'Hoe kan het begrip duurzame woningbouw in Indonesië worden geïmplementeerd?' Dit kan gebeuren door een aantal specifieke potenties van Indonesië die relevant zijn voor duurzame woningbouw te onderkennen en te benutten. Hierna volgen aanbevelingen omtrent strategieën voor duurzame woningbouw voor de verschillende actoren in woningbouwprojecten. Ter afsluiting wordt benadrukt dat een bottom-up benadering een van de belangrijkste voorwaarden is om in Indonesië tot duurzame woningbouw te komen.

PROPOSITIONS

1. 'Housing should be seen not as a product or a commodity that is to be purchased by consumers, but as an activity or a dynamic entity engaged by its inhabitants with the purpose to improve their domestic life.' (from this dissertation)
2. 'Reaching sustainability is a bottom-up process: world leaders, multi-national organizations, national and regional governments may promote it, but in the end it is determined at the local level: local solutions, local resources, local acts.' (from this dissertation).
3. 'I have been impressed with the urgency of doing. Knowing is not enough; we must apply. Being willing is not enough; we must do.' (Leonardo Da Vinci)
4. 'Being "less bad" for the sake of improving environmental quality will not contribute anything significant; changing lifestyle radically for the same purpose will.' (adapted from McDonough & Braungart, *Cradle to Cradle. Remaking the Way We Make Things*, 2002)
5. Human being should stop seeing themselves as the ruler or owner of nature; instead they should start seeing themselves as a part of the whole ecosystem.
6. Indonesians should see sea within the Indonesian archipelago as a connector, instead of as a separator. The challenge is to provide communication and transportation infrastructures that reach even the most remote parts of the archipelago.
7. Design is not value-free science. Design research should always have purposes and is subjective to humanity.
8. 'Good design is suggestive: in architecture this principle means that a building should let the occupants use it how they want. A good building will serve as a backdrop for whatever life people want to lead in it, instead of making them live as if they were executing a program written by the architect.' Paul Graham, *Taste for Makers*, 2002.
9. Desmond Morris mentioned that the greatest survival trick of the human species is being able to keep investigating, while Douglas Adams wondered how it could be that the human species is disinclined to learn from the experience of others. Both points are proven correct.
10. 'In the end, buildings are only buildings, but people make a neighbourhood.' Will Eisner, *Dropsie Avenue*', 1995

These propositions are considered opposable and defendable and as such have been approved by the supervisor, Prof. ir. C.A.J. Duijvestein

STELLINGEN

1. Woningbouw zou niet gezien moeten worden als een product of een waar dat voor consumenten te koop is, maar als een activiteit of dynamische entiteit die wordt uitgevoerd door de inwoners met als doel hun huiselijk bestaan te verbeteren. (uit deze dissertatie)

2. Het bereiken van duurzaamheid is een bottom-up proces: wereldleiders, multinationals, nationale en regionale overheden kunnen het bevorderen, maar uiteindelijk wordt het bepaald op lokaal niveau: lokale oplossingen, lokale middelen, lokale handelingen. (uit deze dissertatie)

3. 'Ik ben behept met de urgentie van het doen. Weten is niet genoeg; wij moeten toepassen. Bereidwilligheid is niet voldoende; wij moeten dóen.' (Leonardo da Vinci)

4. '"Minder slecht" zijn omwille van het verbeteren van de kwaliteit van het milieu draagt niets substantieels bij; een radicale verandering van levensstijl wél (naar McDonough & Braungart, *Cradle to Cradle. Remaking the Way We Make Things*, 2002)

5. De mens moet ophouden zichzelf te zien als de heerser of eigenaar van de natuur; in plaats daarvan moet hij zich gaan beschouwen als onderdeel van het gehele ecosysteem.

6. Indonesiërs zouden de zeeën binnen de Indonesische archipel moeten zien als verbinding in plaats van scheiding. De uitdaging is te voorzien in communicatie- en vervoersinfrastructuren die zelfs de meest afgezonderde delen van de archipel bereikbaar maken.

7. Ontwerpen is geen vrije wetenschap. Ontwerponderzoek zou altijd doelgericht moeten zijn en staat ten dienste van de mensheid.

8. 'Goed ontwerp is suggestief: in de architectuur betekent dit principe dat een gebouw door de bewoners gebruikt kan worden zoals ze willen. Een goed gebouw moet kunnen dienen als de achtergrond voor het leven dat mensen erin willen leiden, in plaats van dat ze erin wonen alsof ze een programma uitvoeren dat is bedacht door de architect.' (Paul Graham, *Taste for Makers*, 2002)

9. Desmond Morris noemde de grootste overlevingstruc van de menselijke soort dat hij in staat is te blijven onderzoeken, terwijl Douglas Adams zich erover verbaasde dat de menselijke soort duidelijke tegenzin toont om van de ervaring van anderen te leren. Beide opvattingen zijn juist gebleken.

10. 'Uiteindelijk zijn gebouwen slechts gebouwen, maar mensen maken een buurt.' (Will Eisner, *Dropsie Avenue*, 1995)

Deze stellingen worden opponeerbaar en verdedigbaar geacht
en zijn als zodanig goedgekeurd door de promotor prof. ir. C.A.J. Duijvestein

CURRICULUM VITAE

Dwinita Larasati (born in Jakarta, Indonesia, 28 December 1972) graduated as an industrial designer from the Institute of Technology Bandung (ITB) in 1997. Her graduation project was about bamboo as a construction material, supervised by Prof. Imam Buchori in collaboration with the Applied Physics Department of the Indonesian Science Institute (P3FT-LIPI) under the supervision of Dr. Bambang Subiyakto.

She acquired her Master's degree (cum laude) from the Design Academy Eindhoven in 1999, partly sponsored by IKEA Stichting Amsterdam and the International Network for Bamboo and Rattan (INBAR). The title of her thesis, which was tutored by Dr. Jules Janssen and Dr. Emilia van Egmond (both from TU/e), is *Uncovering the Green Gold of Indonesia*, about upgrading the value of bamboo and bamboo enterprises in Indonesia.

She started her PhD research at the Faculty of Civil Engineering & Geosciences in 2001, with Prof. Charles Hendriks as her promotor. Since 2004, due to the sudden passing away of Prof. Hendriks, she continued her research at the Faculty of Architecture, under the supervision of Prof. Duijvestein, up to the completion phase.

She has maintained her position as a teaching staff at the Industrial Design Department of ITB, with a special interest in design and sustainability, and will reside in the Northern part of Bandung with her husband and two children.

How can the concept of sustainable housing be implemented in Indonesia? Prompted by various housing problems, especially in dense urban areas, this research proposes an integrated approach towards the sustainability of housing projects, which emphasizes the importance of community participation and the use of local solutions and resources.

In general, existing guidelines and requirements for sustainable housing refer to efficient use of energy and material resources, while minimizing waste. This research analyzes existing examples of sustainable housing implementation in Indonesia (particularly on Java). On the basis of the results, a set of requirements and guidelines for sustainable housing is developed, specifically for conditions in Indonesia.

Furthermore, bamboo is evaluated as a sustainable building material. And finally, as a supplement with this dissertation, a prototype of a communication tool is provided, which can be used by those involved in a housing project: an illustrated booklet which proposes four ambition levels of sustainability for all aspects of a housing project.

ISBN-10: 90-9021487-9 / ISBN-13: 978-90-9021487-0

GUIDELINE FOR SUSTAINABLE HOUSING IN INDONESIA

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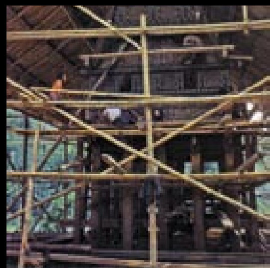


GUIDELINE FOR
SUSTAINABLE HOUSING IN INDONESIA
USING THE DCBA-METHOD

ABOUT THIS BOOKLET
This booklet is produced in order to provide a communication tool that can be used by all parties involved in a housing project.

THE DCBA-METHOD
This guideline uses the so-called 'DCBA'-method. This method suggests how to achieve a certain level of sustainability. Users are guided step by step through all aspects of a housing project. For each aspect they can choose sustainability level D, C, B or A. Option D represents the common or current situation. Option C represents taking the most feasible steps to improve the normal situation towards sustainability. Option B represents more substantial improvements towards sustainability. Option A represents the most ideal situation. The aim is to achieve the highest score possible.

USERS This guideline is intended for people who are involved in a housing project, especially for (potential) inhabitants who need to discuss their wishes and demands among each other and with others who are involved: government, policy makers, developers, investors, contractors, architects, etc.

SCOPE This guideline can only be used for general residential housing projects, although it may also touch the subject of urban planning issues. The discussion includes building elements (walls, ventilation, etc.), but excludes building details (piping, cables, wiring, etc.).

HOW TO USE This guideline provides four options for each aspect of a housing project. Each option is complemented by an illustration which shows an example of what can be done in a certain situation. One housing project would score differently from another, depending on each project's specific conditions.

The DCBA-method is intended to stimulate discussion about the efforts that those who are involved are willing to make in order to achieve the highest level of sustainability possible. The results can be summarized using the scoring card at the back of the booklet, for easy reference.

The overall score represents the needs and desires of the future inhabitants towards their domestic environment. It can be used to communicate about these needs and desires with the authorities or with the developers of the housing project.

STEPS

1. DISCUSS: In each section, discuss which situation is desired for your housing environment. In the case of an improvement project you can start with first identifying the present situation.

2. YOUR CHOICE: Make your choice by ticking the box underneath each section (either D, C, B, or A).

3. REPEAT: Go to the next page, repeating steps 1 and 2.

4. MAKE YOUR LIST: After you have treated all aspects, you can make an inventory of your choices (a scoring card is provided at the back of the booklet).

5. USE IT: Show the list to the developers or authorities of your housing project. You can use the result both as a guideline for implementing certain activities and as a checklist during implementation.

6. ADJUST: Feel free to make adjustments wherever you think necessary for your own neighbourhood, either in the aspects (by adding themes) or the level of gradation (by changing details in D, C, B, or A).

COMMUNITY
NEIGHBOURHOOD RELATIONSHIPS

D ☐

You know the names of your neighbours, but make no further contact.

C ☐

You have social contacts under special circumstances (such as birth, death and marriage).

B ☐

You also have social contacts under casual circumstances (nightwatch, social gatherings, etc.). Communal facilities, such as a guard house, should be provided.

A ☐

Social contacts happen every day and everybody knows everyone. The consequences are for the inhabitants themselves.

NOTE: ....

COMMUNITY
INHABITANTS INVOLVED IN THE PROJECT

D ☐

Nobody is interested to be involved.

C ☐

A few people are willing to participate in communal activities.

B ☐

A majority of inhabitants are willing to participate in communal activities.

A ☐

All inhabitants are involved in communal activities.

NOTE: ....

COMMUNITY
‘GOTONG ROYONG’ (PRODUCTIVE COMMUNAL ACTIVITIES)

D ☐

No ‘gotong royong’ activities.

C ☐

‘Gotong royong’ activities only when an emergency occurs.

B ☐

Occasional ‘gotong royong’ activities.

A ☐

Routine ‘gotong royong’ activities.

NOTE: ....

COMMUNITY
NEIGHBOURHOOD ACTIVITIES

D ☐

No communal activities. Communal needs, such as garbage collecting and neighborhood patrol, are taken care of without direct involvement other than an obligatory fee from residences.

C ☐

Neighbourhood activities such as nighwatch (*ronda*), gatherings (*arisan*) and periodic cleaning (*kerja bakti*).

B ☐

More neighbourhood collaboration, possibly profit-oriented, a co-operation (*koperasi*) and a communal garbage processor, recycling centre and neighbourhood kiosk.

A ☐

Initiating, managing and conducting more complicated communal activities and facilities, and having a positive influence on neighbouring housing projects and villages.

NOTE: ....

COMMUNITY
INITIATORS

D ☐

There is no person in the community who leads, motivates or initiates neighbourhood activities.

C ☐

There is a group of people in the community who motivate and initiate neighbourhood activities.

B ☐

Initiators in a community succeed in encouraging a majority of their fellow inhabitants to participate in neighbourhood activities.

A ☐

Initiators are capable of giving trainings and workshops to their fellow inhabitants and people from other areas as well, who will become their apprentices.

NOTE: ....

COMMUNITY
SPILL-OVER EFFECT

D ☐

Lack of discipline of inhabitants, which has a negative effect on neighbouring areas, such as throwing garbage into sewers.

C ☐

Domestic activities of a housing project having no effect on neighbouring areas.

B ☐

Domestic activities in a housing project having a positive effect on neighbouring areas.

A ☐

Domestic activities in a housing project having positive effects and are examplary for neighbouring areas.

NOTE: ....

COMMUNITY
DRINKING WATER ACCESSIBILITY

D ☐

Difficult access to water source.

C ☐

Use of communal pump.

B ☐

Have the drinkwater delivered to your house.

A ☐

Water from household pump or from your own well.

NOTE: ....

COMMUNITY
ACCESSABILITY OF PUBLIC FACILITIES & SERVICES

D ☐

Lack of or only basic public facilities and services.

C ☐

Primary public facilities and services are available, for example, adequate lighting and easy access to public transport at night.

B ☐

Primary public facilities and services, for example a clinic, are available and easily accessible.

A ☐

All public facilities and services are available and within walking distance.

NOTE: ....

OUTSIDE THE HOUSE
PUBLIC SPACE

D ☐

Lack of or minimum-sized multi-purpose, public space.

C ☐

Minimum-sized public space for basic needs such as passage.

B ☐

Multi-functional public space also for secondary needs such as a greeneries and a playground.

A ☐

Enough public space for various purposes: leisure, gardening, growing food and herbs, greeneries, clean and fresh air.

NOTE: ....

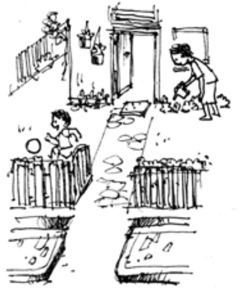
OUTSIDE THE HOUSE
YARD & GARDEN

D ☐

The house does not have a yard or garden.

C ☐

The house has a small yard or garden.



B ☐

The house has enough yard for its inhabitants to conduct outdoor activities such as gardening and playing.

A ☐

The house has a wide garden that allows parking space, gardening, terrace, etc.

NOTE: ....

OUTSIDE THE HOUSE
BUILDING EXPANSION

D ☐

No planning and no space for house expansion.

C ☐

Providing specific space for house expansion.

B ☐

Providing possibilities for house expansion to grow either horizontally or vertically.

A ☐

Providing high flexibility for house expansion.

NOTE: ....

INSIDE THE HOUSE
SPACE

D ☐

Less than minimum standard size (9 m^2 per person).

C ☐

Fulfilling minimum standard size: a moderate size house with fixed interior.

B ☐

Flexible room arrangement: a moderate size house with multi-purpose rooms.

A ☐

Separate rooms for different activities: a big house with one room for each activity.

NOTE: ....

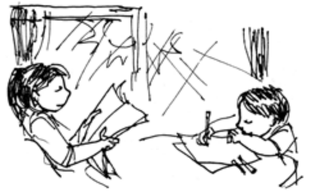
INSIDE THE HOUSE
LIGHTING

D ☐

Use conventional light bulbs, need most lights on both day and night.

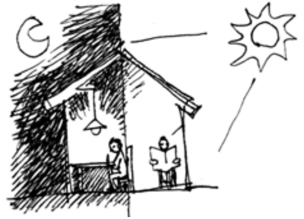
C ☐

Use only energy-saving light bulbs.



B ☐

Efficient use of light and only use natural (sun) light in the day time. The building should be designed so that this principle can be applied.



A ☐

Use natural lights in the day time and solar-powered lights in the night time. The building should be perfectly designed in order to be able to absorb solar power as much as possible.

NOTE: ....

INSIDE THE HOUSE
COOLING

D ☐

No effort to create cool indoor conditions.

C ☐

Try to cool the interior by using conventional air conditioners that release substances which are harmful for the ozone layer.

B ☐

Try to cool the interior by using energy-efficient, eco-friendly airconditioner.

A ☐

Cool the interior by providing adequate ventilation that allows air flow – no air conditioning (involvement of an architect is necessary).

NOTE: ....

INSIDE THE HOUSE
AIR & NOISE POLLUTION

D ☐

No specific efforts against air and noise pollution.

C ☐

Minimize use of household appliances that cause air & noise pollution (small prevention, temporary solution).

B ☐

Enough ventilation to circulate air, especially in the kitchen area (elaborate effort against indoor pollution, permanent solution).

A ☐

Provide a separate room for noisy and air-polluting activities and using building materials that absorb noise.

NOTE: ....

INSIDE THE HOUSE
WATER & ELECTRIC FACILITIES

D ☐

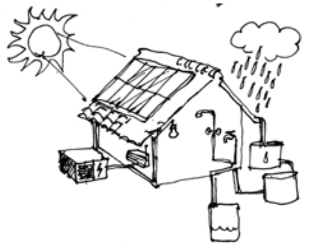
No access to water and electricity grids.

C ☐

Water and electricity facilities are provided after the housing is ready.

B ☐

Water and electricity facilities are already integrated during the building process.



A ☐

Generate your own electricity and use your own closed water system.

NOTE: ....

BUILDING COMPONENTS
ASSEMBLAGE

D ☐

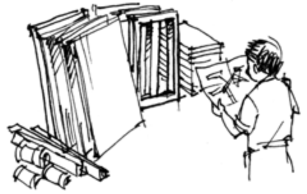
Use conventional building (heavy) machines, tools and joints.

C ☐

Use manual tools over heavy machines whenever possible.

B ☐

Labor intensive assembling process (professional workers or relatives in a 'gotong royong' event).



A ☐

Intermediate technology, self-assembled components.

NOTE: ....

BUILDING COMPONENTS
SIZE

D ☐

Custom-made building components, for example raw bamboo that has no standard size or specially ordered building components.

C ☐

Also use standard-sized building elements whenever possible.

B ☐

Reduce the use of non-functional, and non-structural building elements whenever possible.

A ☐

Use of building materials very efficient, only standard-sized commercial building elements.

NOTE: ....

BUILDING COMPONENTS
DURABILITY & MAINTENANCE

D ☐

No efforts to maintain or fix building components.

C ☐

Fix components only when they break.

B ☐

Occasional checking and cleaning, for example floors, ceilings, walls and bathrooms/ water containers and toilets.

A ☐

Regular checking and treatment, for example painting walls and replacing aged components.

NOTE: ....

BUILDING COMPONENTS
PRE-FABRICATION

D ☐

Choose one of the readily available knock-down houses (full involvement of a contractor).

C ☐

Have a commercial knock-down house modified to your wishes (still involves a contractor).

B ☐

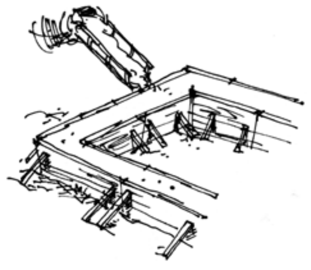
Combine a modified knock-down house with eco-construction (a contractor still has a role in modifying the design).

A ☐

Also use pre-fabricated components whenever possible for efficiency reasons and fully build the house yourself.

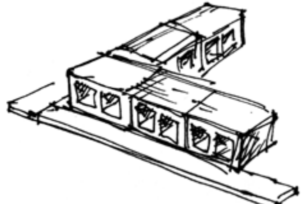
NOTE: ....

MATERIALS
FOUNDATION



D ☐

Concrete foundation.

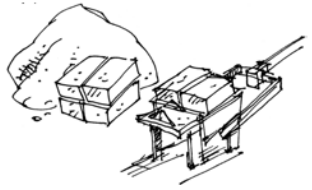


C ☐

Concrete blocks, which are more practical and use less resources compared to concrete.

B ☐

River stones, requiring even less concrete.

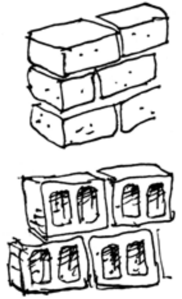


A ☐

Compressed earth blocks, or timber for a stage house.

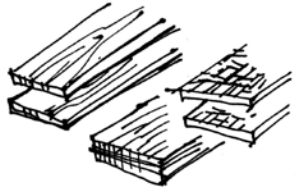
NOTE: ....

MATERIALS
WALLS



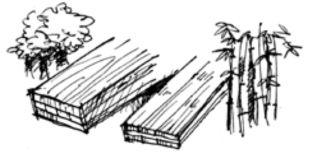
D ☐

Use concrete blocks



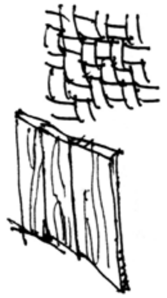
C ☐

Use red bricks or industrially produced board with formaldehyde glue



B ☐

Use eco-labelled wooden or bamboo boards

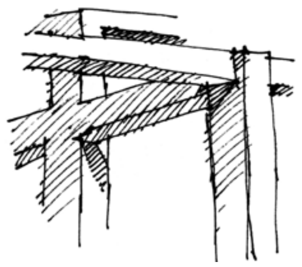


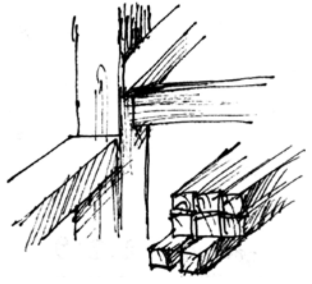
A ☐

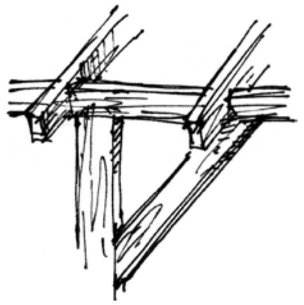
Use sustainable and organic materials such as woven bamboo, coconut fiber and clay composite

NOTE: ....

MATERIALS
BUILDING FRAME







D ☐

Concrete or steel.

C ☐

Reduce the amount of concrete used and use of industrial timber.

B ☐

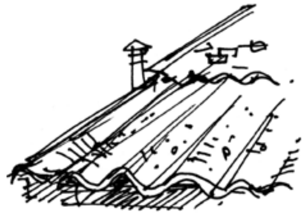
Use eco-labelled timber.

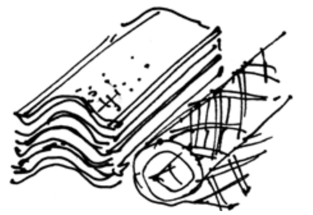
A ☐

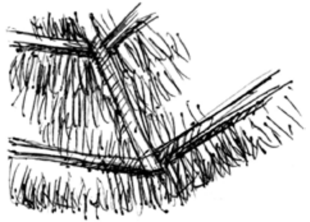
Use local timber from forests that provide re-planting.

NOTE: ....

MATERIALS
ROOF







D ☐

Use corrugated asbestos sheet or corrugated iron/ zinc sheet.

C ☐

Use ferrocement or concrete roof tiles.

B ☐

Use ceramic tiles.

A ☐

Use locally-made ceramic roof tiles, high recycled content clay or thatches (straw, reeds, etc.).

NOTE: ....

SOURCES
MATERIAL SOURCES

D ☐

Buy conventional building materials from common suppliers.

C ☐

Buy alternative, locally-grown or produced building materials from local suppliers.

B ☐

Buy eco-labelled building materials from environmentally-conscious suppliers.

A ☐

Grow or make your own building materials.

NOTE: ....

SOURCES
ENERGY SOURCES

D ☐

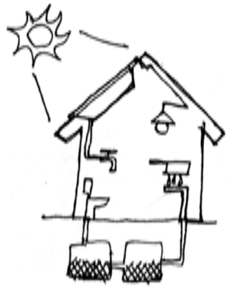
Conventional energy sources: state-owned electricity grids and LPG.

C ☐

Also use alternative energy sources.

B ☐

Only use alternative energy sources: solar energy for generating electricity, heating water, cooking, etc.

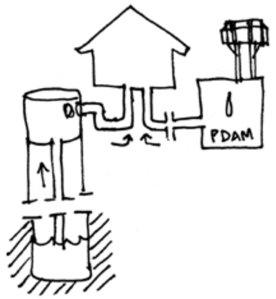


A ☐

Only use alternative energy and generate own energy from direct resources such as a biofuel gas, without depending on other sources.

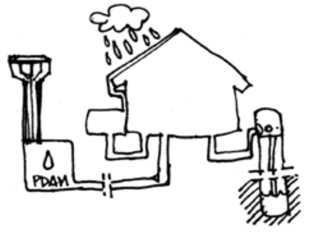
NOTE: ....

SOURCES
WATER SOURCES



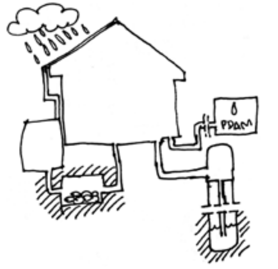
D ☐

Water from (state-owned) water company or from your own well.



C ☐

Add collected rain-water for household purposes other than drinking/cooking.



B ☐

Add collected and purified soil or rain water.

A ☐

Water from your own well, added by purified soil or rain water.

NOTE: ....

SOURCES
DRINKING WATER

D ☐

Scarce water source or inferior quality soil water.

C ☐

Availability of state-owned drinking water source.

B ☐

Possibility to have household wells and pumps or small-scale communal pumps.

A ☐

Abundant source of soil water.

NOTE: ....

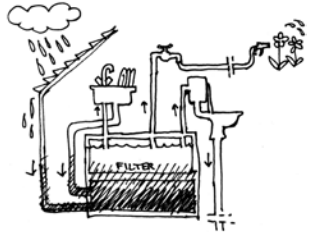
WASTE
WASTE WATER

D ☐

Throw waste water directly to sewers through water drainage pipes and let rain-water directly fall into sewers through drainage pipes.

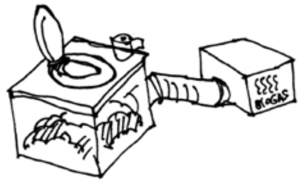
C ☐

Directly re-use grey water for example for watering plants, gardening, washing bikes or cars.



B ☐

Filter grey water for household purposes, other than drinking or cooking and use water efficiently to reduce waste water, for example by using a water-saving tap.



A ☐

Cut the use of water as much as possible or minimize waste water, for example by using a dry toilet.

NOTE: ....

WASTE
HOUSEHOLD WASTE

D ☐

Directly dispose used packages and products, and mix all kinds of waste in one bin.

C ☐

Re-use packages and products and separate bio-waste from the rest of the garbage.

B ☐

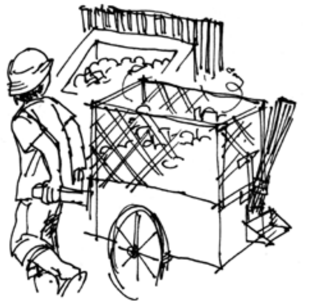
Re-use and recycle disposables for your personal or household use and separate household waste more precisely: bio-waste, paper, plastic, glass, etc.

A ☐

Also make income out of re-used and recycled household waste.

NOTE: ....

WASTE
GARBAGE DISPOSAL



D ☐

Conventional garbage container (for mixed waste) in the form of a hole in the ground, a drum or a garbage container, with waste to be collected by the municipality.

C ☐

Separated containers for different types of garbage, with waste to be collected by the municipality.

B ☐

Separated waste, partly to be collected by the municipality and partly to be self-processed.

A ☐

Self-process all types of waste: turn bio-waste into compost/fertilizer, paper waste into paper products, re-use glass and plastic waste or submit them to a recycling centre, dispose chemical waste to a special disposal counter.

NOTE: ....

WASTE
CLEANING AGENTS

D ☐

Use commercial, chemical cleaning agents.

C ☐

Minimize the use of commercial cleaning agents and use natural alternatives whenever possible such as using lavender instead of insecticides to repel mosquitos.

B ☐

Use only natural, bio-degradable cleaning agents.

A ☐

Self-produce and use natural cleaning agents.

NOTE: ....

MONEY MATTERS
BUILDING FINANCE

D ☐

Conventional mortgage or ordinary interest system with a bank.

C ☐

Special loans/soft credit for housing with a housing co-operation (subsidized).

B ☐

Partially financially self-supportive and build some parts of your house yourself, with the 'gotong royong' system and using your own money.

A ☐

Having the right amount of money to purchase or build a a new house.

NOTE: ....

MONEY MATTERS
CERTIFICATION

D ☐

A time-consuming, expensive and complicated process to acquire certificates.

C ☐

A time-consuming and complicated process to acquire certificates, within reasonable expenses.

B ☐

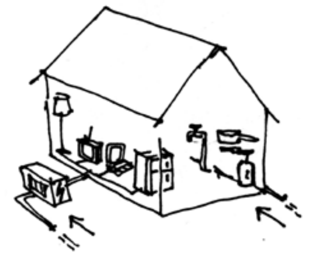
A complicated process to acquire certificates, within reasonable expenses and time span.

A ☐

A fast, practical process without complications in acquiring complete and valid certificates.

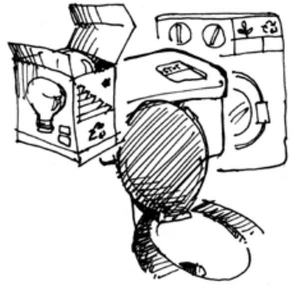
NOTE: ....

MONEY MATTERS
ENERGY COSTS



D ☐

Ordinary energy-consumptive household.

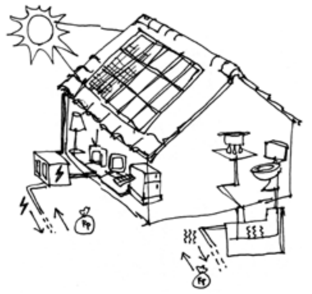


C ☐

Reduce energy consumption by using energy-saving appliances.

B ☐

Efficient energy use by having a control panel for energy and water consumption and being partially energy-productive by having a solar water heater.



A ☐

Money-generating household: housing as a production unit by producing energy with a solar electricity generator.

NOTE: ....

MONEY MATTERS
THE HOUSE AS A PRODUCTION UNIT

D ☐

Ordinary household.

C ☐

Home office or a family member works at home.

B ☐

Shop house or an establishment that functions both as a shop and a residence.

A ☐

Household and cottage industry.

NOTE: ....

✎ OVERALL SCORE

PEOPLE

COMMUNITY	D	C	B	A	#
Neighbourhood relationships					4
Involvement of habitants					5
'Gotong royong'					6
Neighborhood activities					7
Initiators					8
Spill-over effect					9
Drinking water accessability					10
Accessability of public facilities					11

PROJECT

OUTSIDE THE HOUSE					
Public space					12
Yard & garden					13
Building expansion					14

INSIDE THE HOUSE					
Inside space					15
Indoor lighting					16
Indoor colling					17
Air & noise pollution					18
Water & electric facilities					19

BUILDING COMPONENTS					
Assemblage					20
Size					21
Durability & maintainance					22
Pre-fabrication					23

PLANET

MATERIALS	D	C	B	A	#
Foundation					24
Walls					25
Building frame					26
Roof					27

SOURCES					
Material sources					28
Energy sources					29
Water sources					30
Drinking water					31

WASTE					
Waste water					32
Household waste					33
Garbage disposal					34
Cleaning agents					35

PROSPERITY

MONEY MATTERS					
Building finance					36
Certification					37
Energy costs					38
The house as production unit					39

Supplement accompanying the dissertation
Towards An Integral Approach Of Sustainable Housing in Indonesia.
With An Analysis of Current Practices in Java
by Dwinita Larasati, presented and defended on January 11th, 2007
at Delft University of Technology, the Netherlands