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Introduction

The research focuses on **building technologies** for **resilient, permanent urban housing** for **low income inhabitants**.

Key Question:
How can the housing deficit be tackled in a sustainable way?
Introduction
Partnerships for Opportunity:

• ETH Zurich- Chair of Sustainable Construction
• Homeless People’s Federation of the Philippines
• United Nations ESCAP
• HILTI Foundation
Resilient & Permanent Urban Housing

• **Governments** have largely failed to provide housing

• **International efforts** focus strongly on transitory or rural housing

• **The market** has difficulties to reach the bottom of the pyramid

→ The urban poor face reality by constructing their own shelter in an incremental process
Why alternative technologies?

- Accepted by dwellers
- Associated with strength and durability
- Established on the market

Conventional structure

Is this the solution for 100,000 housing units /day?

- Lack of quality control in production & construction → low cost = low quality
- High resource consumption through inefficiency & wastage
- Mostly above the level of affordability
- Logistics & time demand
- Environmental impact
- Et cetera …

→ Conventional methods have optimization potential, but limited
Performance Criteria

A clearly defined need is the basis for assessing performance!

• Initial Construction Costs per m², Economy of Scale
• Quality Control & Technical Performance
• Local value creation
• Time Schedule
• Requirements Production Process | Construction Process
• Modularization and Flexibility
• Durability
• Maintenance needs
• Environmental Performance
Content

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➤ Alternative building technologies- an inventory

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An Inventory

Which technologies are available today?

Global Research – creation of technology database

Data Sources were from International / Bilateral Organization, Private Sector, Research

Where are promising trends and potentials?

Screening of the technologies according to criteria

The inventory has a **global viewpoint** and does therefore not deliver a direct technology recommendation. For latter, the local needs have to be considered.
Technology Database

Three organizational levels:

• First Order Category: **Building Material**
  00 Natural Stone      04 Timber
  01 Earth / Soil       05 Bamboo
  02 Metal              06 Synthetically Materials
  03 Concrete           07 Others

• Second Order Category: **Structural Elements**

• Third Order Category: Fact sheet summarizing key characteristics according to the above mentioned criteria
## Technology Inventory

### 01- Earth / Soil with Stabilization

**MONOLITHIC**
- 1_01 Rammed earth walls

**STRUCTURE**
- 1_02 Wattle and Daub
- 1_03 Bamboo reinforced earth walls

**BRICKS**
- 1_04 Adobe Blocks, handmade, sun dried, no cement
- 1_05 Sand-Lime brick
- 1_06 Laterite blocks
- 1_07 Stabilized Compressed Soil Cement Blocks
- 1_08-09 Stabilized Compr.Soil Blocks with enzyme or fibres
- 1_10 Cement Waste Slag Blocks / Cinder Blocks
- 1_11 Fal-G Brick
- 1_12 Hollow Stabilized Blocks with Rat Trap Bond
- 1_13 Interlocking Hollow Cement Earth Block Mortarless
- 1_14 Burned Red Clay Bricks and Tiles
- 1_15 Hollow Masonry Brick, Rat Trap Bond, Vertical Oven

### 02- Metal

- 2_01 Streel Frame, Cladding: Earth Block, Burnt Brick, Mesh reinforced sand/cement plaster, Polystyrol
- 2_05 Metall Panels and Steel Frame
- 2_06 Container Houses, imported

### 03- Concrete

**Prefab Panels**
- 3_01 Prefab Large Concrete Panels
- 3_02 Cellular Concrete Panels, foaming agent and flyash
- 3_03 Concrete Panels, animal foaming agent, or straw fibre
- 3_04 Hollow Concrete Panel, fibre or wire reinforcement
- 3_05 Concrete Panels/Bricks, agro waste fibres
- 3_06 Concrete Panel, incorporated glass
- 3_07 Concrete Hooking Panel
- 3_08 Prefab Waffle Walls
- 3_09 Tunnelform System
Technology Inventory

03- Concrete

- 3_10 Massive Concrete Block
- 3_11 Hollow Concrete Block with Mortar
- 3_12 Core Housing with Hollow Concrete Blocks
- 3_13 Interlocking Hollow Concrete Block Mortarless
- 3_14 Further Lime and Pozzolane Technologies
- 3_15 Safe(R) House
- 3_16 Concrete Block with Chemical Additive

In situ Walls

- 3_17 Ferrocement Sandwich, aerated concrete core
- 3_19 Reinforced Concrete Frame, Brick & Mortar filling
- 3_20 Insitu Concrete, Aliminum Formwork
- 3_21 Insitu Concrete, Plastic Formwork
- 3_22 Composite Cement Fibre Board
- 3_23 Steel Wire, EPS Core, Shotcrete

04- Timber

- 4_01 Timber Panel House with RCC Columns
- 4_02 Plywood Panel with foam core
- 4_03 Massive Timber Plug-In System
- 4_04 Timber frame, Stilt House
- 4_05 Prefabricated Core Housing
- 4_06 Plywood Structure using Secondary Timber

05- Bamboo + Natural Fibres

- 5_01 Bamboo Columns with plain bamboo cover panels, traditional
- 5_02 Plain Bamboo or Bamboo Wood Frame, different cover panels
- 5_03 Bamboo filled with straw balls bamboo with ferrocement
- 5_04 Plybamboo wall mat panels (bamboo or timber joints)
- 5_05 Plybamboo wall strip panels (bamboo or timber joints)
- 5_08 Bambusbeton (Bambus als Zuschlagsstoff)
- 5_09 Natural Fibre Panels
Technology Inventory

06- Synthetical Material

**Load Bearing Plastics**
- 6.01 Sandwich Element Climate House with Steel Frame
- 6.02 Ferro Polystyrol (Steel wire with Polystyrol Core)
- 6.03 Polystyrol EPS Walls
- 6.04 Fibre cement skin with polystyrene core and metal clips
- 6.05 Insulated Concrete Forming System

**Waste Plastics**
- 6.07 TPR, Thermo Poly Rock, Low Carbon Housing
- 6.08 Utilisation of waste plastic for insulation or packing
- 6.09 Hazardous Waste for Cement Production
- 6.10 PET Bottles
- 6.11 Melted waste plastic as replacement for bitumen in stabilized bricks
- 6.12 Byfusion Block

07- Others

- 7.01 Paper Honey Combs
- 7.02 Paper Log House
- 7.03 Corrugated Fiberboard
- 7.04 Miscanthus Walls
- 7.05 Rapid Prototyping, Contour Crafting
3_21 Insitu concrete with plastic formwork

Technology source: www.moladi.com
Beside all possible criteria...

“The main difference between the success and failure of housing delivery is the degree to which poor people themselves are involved."

World Development Report, 2004

Methodology to make use of the technology inventory:

• Selection of top technologies together with people → adjustment to local criteria

• Additional decision criteria possible to integrate e.g. ecological performance with Life Cycle Assessment
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Status Quo of the Project Region

May 2011 Philippines
Partnership with people representatives

The Homeless People’s Federation of the Philippines...

Motivate | Organize | Encourage savings | Share best practices

...among thousands of members

Philippines 2011
Participatory Action Research
Pre-selection with the Homeless Federation & the Grass Roots
Pre-Selection Process

Most relevant criteria defined with the Homeless Federation:

Level of Affordability
- Initial Construction Costs of 40 - 90 $ per m² built up area

Added Value to the Region
- Value creation in the country & on community level
  - Tradition | Material | People’s Integration

Resistant quality-structures
- Technical Requirements- earthquake and typhoon
- Simplification during construction, but quality increase where needed

→ Identification of the 3 top technologies
1. Interlocking Mortar-less Blocks

- Material optimization, use of waste stream
- Process optimization on construction site
- Cost reduction 30-50 per cent
- Technical properties tested

Source: HPFPI & Own Pictures 2011
2. Coir Fibre Board Construction

Source: Van Dam 2005, Kejisers 2006
3. Bamboo Frame & Mat Boards

Source: BMTPC 2008; Bamboo Technologies 2009
Life Cycle Assessment - LCA

Most established method to measure ecological performance of products & services:

- Identification of improvement potential in the life cycle of a product
- Comparison of environmental impacts of products with the same function
Life Cycle Assessment- LCA

Summary of all MASS & ENERGY FLOWS throughout LIFECYCLE

CRADLE TO FACTORY GATE | CRADLE TO CONSTRUCTION
CRADLE TO GRAVE
Impact Assessment

Impact2002+

Source: Jolliet et al., EPFL 2003
Results Base Case
Base Case “Cradle-to-Construction” plus “Waste Scenario” for three alternative construction technologies—coir, bamboo, interlocking blocks—compared to conventional reference.

Comparing all technologies 25a, base case, CradletoConstruction & WasteScenario
Method: IMPACT 2002+ V2.10 / IMPACT 2002+ / Single score

Environmental Saving

90% 78% 28%
Results Cradle to Factory Gate

Impact Analysis Bamboo Mat Board Base Case

Analyzing 11 kg ‘Bamboo Mat Board, base case’;
Method: IMPACT 2002+ V2.10 / IMPACT 2002+ / Single score
Results Sensitivity Scenarios

Min | Base | Max Scenarios “Cradle-to-Construction” plus “Waste Scenario” for 3 alternative construction technologies - coir, bamboo, interlocking blocks - compared to conventional reference

Considered time horizon: 50 years
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Conclusions- Overall

• The technology inventory helps to visualize options, which then need to be proven on local scale

• Alternative construction technologies are more than just a building envelope! They can be a driver for inclusive and sustainable urban development- economic, social & ecologic!

• One criterion alone does not deliver a decision, but in a combined set-up with the people, criteria can guide the decision process by giving quantitative arguments

• LCA is an effective tool for measuring environmental performance and it has significance for low income houses
We build a better future – together

Thank you

Extensive results will be published in 2012
Please contact corinna.salzer@hilti.com or mark the “keep me informed“ in case of interest