

Sustainable Construction in Costa Rica:
Strategic approach to construction material management for waste reduction

Subject

The Construction sector takes up to 50% of all materials extracted from the earth's crust and in combination with energy produces goods and huge amounts of waste. And the question is why so much material is lost as waste?

Goal

It is to report the results of a baseline study performed in the Costa Rican construction sector with the attempt to provide information about quantities, composition and causes of construction waste production while the procurement of buildings.

Results

The survey revealed values in construction waste ranging from 7 to 170 kg/m².

The composition is mainly wood, steel, mortar and concrete among others.

The causes are related to legislation, awareness technical aspects and profits.



Construction waste dumped in the ocean



Construction waste dumped on a river side

Table 1. Waste generation technical aspects

| Technical causes |
|--|
| Design |
| Choices about specifications of products |
| Incompatible standard sizes available on the market |
| Lack of influence of contractors and lack of knowledge about construction |
| Changes made to the design while construction is in progress |
| Designers unfamiliarity with alternative products |
| Incomplete contract documents at the beginning of the project |
| Errors in contract document |
| Selection of low quality products |
| Complexity of detailing on the drawings |
| Procurement |
| Ordering errors (too much, too little) |
| Lack of possibilities to order smaller quantities |
| Material handling |
| Use of products that don't fit |
| Materials supplied in loose form |
| Unpacked supply |
| Damages during transportation |
| Inappropriate storage leading to damage or deterioration |
| Throwaway packaging |
| Operation |
| Use of incorrect material, thus requiring replacement |
| Damage to work done caused by subsequent subcontractors |
| Bad weather |
| Required quantity unclear due to improper planning |
| Delays in passing of information to the contractor on types and sizes of products to be used |
| Accidents on the construction site |
| Errors by tradespersons or labourers |
| Equipment malfunctioning |
| Residual |
| Conversion waste from cutting uneconomical shapes |
| Purchased products that do not comply with specifications |
| Off cuts from cutting materials to length |
| Waste from application process |
| Packaging |
| Other |
| Environmental unfriendly attitude of project team and labourers |
| Criminal waste due to damage or theft |
| Lack of on site materials control and waste management plans |
| Natural disasters |

Expected Results

Mathematical and descriptive model for construction material management

An improved MFA approach for the construction sector

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Research topic:

The construction sector plays a key role in shaping and developing the built environment. It also has an undisputed and significant impact on it. As much as 50% of all materials extracted from the earth's crust are transformed into construction materials and products while many of them end up in formidable amounts of pollution and waste generation.

In developing countries, construction waste is becoming a serious environmental problem due to the fact that the construction industry generates lots of construction waste, which causes significant impacts and arise growing public concern in the local community. In developed countries the focus to reduce the environmental footprint of the construction sector have been, among others, through recycling which is an end-of-pipe solution with low rates of recycling being achieved.

Building energy-use has been studied quite extensively and research efforts have been implemented in practice, but the environmental impacts of other parts of the infrastructure, especially construction materials and processes have thus far gotten unjustifiably limited research attention. Few studies are found in the literature related to the situation of the sector in relation to construction materials and waste management in low-income economy countries.

The prevention of wastes will reduce the building's environmental impact by reducing the depletion of natural resources such as trees, oil and minerals, and produce less pollution by reducing manufacturing and transportation-related emissions, usage of less energy and water compared to many virgin material product manufacturing processes and reduction of greenhouse gases by using less energy for manufacturing and transportation.



This research intends to reveal the opportunities and obstacles for transfer, adoption and incorporation of environmentally friendly practices in the building procurement (at present absent) in the context of a developing economy, in order to change the traditional construction system, into a more sustainable one. It focuses on construction materials (mainly concrete, mortar, steel and wood) and construction processes. It tries



to look into product processes in order to explain the factors that influence the production of waste by means of analysing the situation of material management, during the procurement of buildings in Costa Rica, Central America. The project draws both on deep connections to the construction industry, and its professional practices, and on the potential to put this industry into contact with innovations, methods and changes which take place in the construction industry in developed countries. The achievements of this research are:

- (i) Mathematical and descriptive model for construction material management
- (ii) An improved Material-Flow-Analysis approach for the construction sector.

The research will gain insight in the sustainability of innovations in material management, waste prevention and waste management in developing countries. Its societal relevance concerns the incorporation of a more sustainable construction activity to positively impact homeowners, contractors and the environment, and includes costs, resource conservation and marketing.

The approach to be used is grounded in the theories of industrial metabolism which studies material and energy flows, is applied for analysis of processes, it has an emphasis on physical flows, it is quantitative and life cycle oriented and it attempts to minimize the environmental impact of these flows.

Keywords: Material management, waste, prevention, on-off site production, construction, sustainability, construction sector, innovation.

Research period: Jan 2006 – December 2011



Publications:

- **Abarca Guerrero, L., Scheublin, F.M. and Egmond van, E. (2008)**
Sustainable construction in Costa Rica. In Proc.: BuHu 8th International Post-graduate Research Conference, Prague, Czeck Republic.
- **Abarca Guerrero, L., Scheublin, F.M. and Lambert, A.J.D. (2009)**
Construction process assessment or “black box opener”. In Proc.: Conference Lifecycle design of buildings, systems and materials, and CIB W115 Construction Material Stewardship 3rd Meeting, University of Twente, Netherlands June 2009
- **Abarca Guerrero, L., Scheublin, F.M., Egmond van, E. and Lambert, A.J.D. (2009)**
Metabolism of materials by the construction sector in developing countries: Costa Rica as case study. In Proc.: 3rd CIB International Conference on Smart and Sustainable Built Environments, SASBE09, Delft University of Technology, Netherlands, June 2009