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Sustainable Construction in Chile: a diagnosis

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Abstract
The construction sector plays an important role in the sustainable development of a country. However, in Chile, activities in the field of sustainable building practices are still in a preliminary phase and specific legislation in this area barely exists. Only little information on sustainable building activities is documented and available. The aim of this paper is to explore the efforts taken by the government and the building industry towards environmental building practices, enabling the generation of policy-ideas for the future improvement of the status of sustainable construction in Chile. The paper includes information about the current government response in the form of policies and policy instruments, the industry actions regarding sustainability, and the environmental awareness of designers, contractors, and the government as it is demonstrated by the attitude of these actors towards the environment. Finally, barriers to sustainable construction practices are also reported. An interesting conclusion obtained from this research effort is that there is a mismatch between the industry's vision and the government perception on the constraints towards environmental building practices in our country.

Keywords
Sustainable construction, government, diagnostic, barriers.

INTRODUCTION

The debate on the environmental consequences of economic growth and the importance of sustainable development has moved up the international agenda. This has been reinforced by trade liberalization and increasing globalization of the world economy. It is a direct response to the global problems of natural resource depletion and degradation, waste generation and accumulation, and environmental impact and degradation (Vanegas, 1998). The construction sector is one of the largest sectors in terms of resource consumption and waste production in the world. Therefore, sustainable building is an essential factor in achieving sustainable development (Sunikka, 2001). During the World Summit on Sustainable Development 2002 in South Africa, Agenda 21 for sustainable construction in developing countries was published. This shows the increasing interest and the need for focusing on the process of sustainable construction in less developed countries.

Chile is still considered a developing country, although qualified as an upper middle-income country by the World Bank. This implies on the one hand that the process of economic growth has increased the pressures on the environment and on the other, that the government has the means to begin acting

on sustainable development. In this context, the challenge for Chile, and comparable countries, is to protect and conserve the environment without undermining the economic development.

DESCRIPTION OF THE RESEARCH

The main goal of this research was to carry out a study of the status of construction sustainability in Chile. To achieve this it was necessary to find out a useful and practical methodological approach. This methodological approach had to consider how to transform information obtained from opinions, facts and literature, into measurable indicators. Sustainability is a multidimensional concept, which needs more than one indicator to be characterized.

The research instrument of this study was then developed by means of defining construction sustainability development indicators. These indicators might be especially useful for policy-making. Namely, with the help of these indicators, information on environmental problems is supplied in a structured way, providing a solid basis for the formulation of conclusions. The use of sustainability indicators could enable policy-makers to evaluate the seriousness of different problems. A second advantage is therefore that the identification of key factors causing pressure on the environment would support policy development and priority setting. Finally, and not the least important, the effects of policy responses can be monitored

The response variable for sustainable construction in Chile was divided into:
- Government response, in the form of policies and policy instruments, facilitating, stimulating, and regulating the actual environmental protection process,
- Industry response, as being the environmental protection process defined as all actions and measures taken by designers and construction companies directly for reducing pressures on the environment, and
- Environmental awareness, referring to environmental awareness of designers, construction companies, and the government. It reflects the attitude of these actors towards the environment.

The construction industry is represented by designers and construction companies. Their response is expressed by actions and measures taken to protect the environment. The response of the government is taking shape in the form of an environmental policy directed towards the building industry. Table 1 serves as an introduction to the operationalization of the response variable.

Table 1. Global indicators of sustainability development

STATE OF SUSTAINABLE CONSTRUCTION	
Government Response	Direct regulation Indirect regulation Self regulation
Industry response	Environmental considerations in design process Environmental considerations in production process Advances in technology
Barriers	Knowledge/ attitude Market / financial Process / technology Government / policy

Data collection

Three different data collection methods were used for this research. First, literature was used to describe the context of actions taken in the policy field as well as in the construction industry. Most of the information came from the libraries of the National Commission of the Environment (Comisión Nacional del Medio Ambiente, CONAMA) and the Chilean Construction Chamber (Cámara Chilena de la Construcción, CChC).

To determine the government response, key persons from the policy field were interviewed. Few public organizations related to the construction industry were relevant for this research. The topics included in the interview were: 1) to what extent the construction sector is considered to be a producer of pollution, 2) which policy instruments regarding sustainable construction are currently available, 3) what have been the impact of these instruments and the legal power of public organizations, 4) future developments, and 5) barriers to sustainable construction.

The organizations included in the study were the Ministry of Public Works (Ministerio de Obras Públicas, MOP) and the Ministry of Housing and Urban Development (Ministerio de Vivienda y Urbanismo, MINVU). Furthermore, key-persons from the National Commission of the Environment, and the National Council of Clean Production (Consejo Nacional de Producción Limpia, CPL) have been interviewed.

The third data collection method was a survey used for measuring the attitudes and opinions of construction people towards sustainable construction practices. Two groups of stakeholders of this sector were included in this research, namely; 1) construction companies, and 2) designers.

Most questions have a categorized rating scale and some have a comparative one. A five-point scale was used in case.

RESULTS

Government response

From the response of the government, the following can be concluded.

The most important direct policy instruments are the designation of waste-yard places, the environmental impact assessment regulation (EIA), and the thermal regulation for housing. No norms are specifically dealing with construction and demolition waste, although some rules are available regarding the transport of dangerous waste. Recently, four waste-yards were made available in Santiago for construction waste by the government. The EIA is applicable to large investment projects both, public and private, and controls the fulfillment of environmental regulation. In practice, building projects are not subjected to the EIA. The thermal regulation as yet is only applicable for the roof design of houses. In the near future, regulations are planned for the other parts of buildings envelope.

With regard to indirect policy instruments, it can be concluded that pricing and tax related policies are non-existing in Chile. Opinions differ on the possibilities for the application of these instruments in the design of environmental policies. Important barriers are the article in the Constitution that prohibits decisions on the destination of general taxes, and the lack of knowledge on the implementation of economic instruments at policy level in Chile.

The Chilean government also makes use of self-regulation instruments. In this context, it is promoting the application of a Clean Production Agreement for the construction sector. This agreement is applicable to construction companies and deals with the themes of dust (particular matter), noise, and solid waste. In addition, some information provision in the field of sustainable construction takes place. The most important information provided by the government, are the three demonstration projects of the Ministry of Public Works showing their architects how environmental aspects can be integrated in the design phase. The demonstration projects are still in the design phase and no evaluation or information diffusion has been put in practice yet. The Chilean Construction Chamber provides environmental information in the form of three manuals for construction companies on how to minimize the effects (dust, noise, and solid waste) of construction activities.

The objectives and target groups of the most important current environmental policies in Chile are summarized in table 2.

Table 2 Objectives and target groups of environmental policies

Target group	Objectives / themes		Policy instrument type
	Energy	Solid Waste	
Designers	Thermal regulation (MINVU)		Direct regulation
	Demonstration projects (MOP)	Demonstration projects (MOP)	Self regulation (information provision)
Construction companies		Related norms, landfills	Direct regulation
		Clean production agreement	Self regulation

As a general conclusion, it can be stated that the current available environmental policy is based on direct policy instruments and only partly covers the construction sector. This part is focused on the construction process and related themes of dust, solid waste, and noise. Finally, there is a lack of attention for embodied energy in material issues in current environmental policy.

As an overall conclusion on environmental awareness in the policy field, it can be stated that this is not sufficient. Interest for and knowledge on the environmental theme in general and environmental building practices in particular is missing at the Ministry of Housing and Urban Development. The Ministry of Public Works is a little more preoccupied with the environmental theme which is reflected by some few actions like the creation of the Environmental Administration office and the participation in demonstrations projects. A positive development is the growing attention given to environmental issues by the Chilean Construction Chamber.

The key-persons in the policy field see most barriers against construction sustainability in the sphere of knowledge and attitude. According to them, the lack of awareness and knowledge in Chile in general and in the industry is an important constraint towards environmental construction practices. Directly related to this, a lack of attention in the educational system of Chile is also considered a big constraint. As the second most important group of barriers, the key-persons mentioned financial and market constraints. A main aspect is the short-term thinking of the decision-makers versus the long-term stretch of sustainability. Less significant constraints are of a technology or policy nature, although a lack of interest at policy level was mentioned.

According to the same stakeholders, a first solution to face these constraints is education. Universities should play an important role in this by offering integrated sustainability education. The opinions on

which policy instrument types will be most effective differ significantly. Three individual recommendations are: 1) to increase the application of prefabrication and industrialization, 2) a leading role by the government, and 3) monitoring data on environmental impacts.

Building Industry response

This section presents the actions taken by designers and construction companies as a response to the demands of construction sustainability.

Designers

The designers' environmental construction practices are divided into 1) energy concerns in design, 2) application of energy saving measures, and 3) waste and material considerations in design.

As shown in figure 1, the application of roof insulation design scores higher than the three other groups. According to respondents, in 90% of their projects roof insulation is applied. Walls are insulated in 65% of the cases, windows (meaning the application of double glass) in 40% of the projects, and still in 30% of the projects floor insulation is applied.

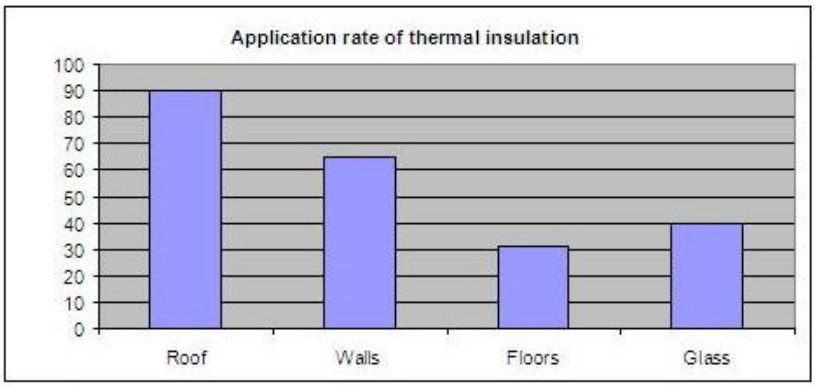

Fig. 1 Energy concerns in design

Figure 2 shows the energy-related issues addressed by design practices. The long-standing basic design concepts of orientation of the building to the north and natural ventilation are most often applied, probably also due to the easiness and low costs for their application.

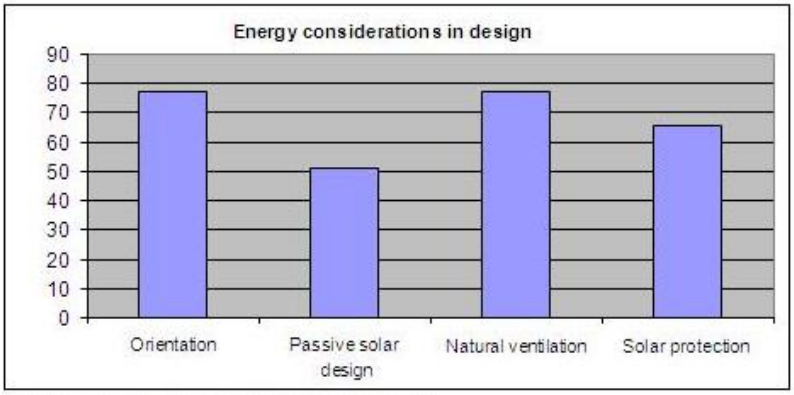

Fig. 2 Energy issues in design

As shown in figure 3 the use of standard building material scores extremely high in relation to the other waste and material considerations in design. According to respondents, about 86% of the projects are designed using standard building materials. Renewable materials and recycled materials are only used in respectively 5 and 10%.

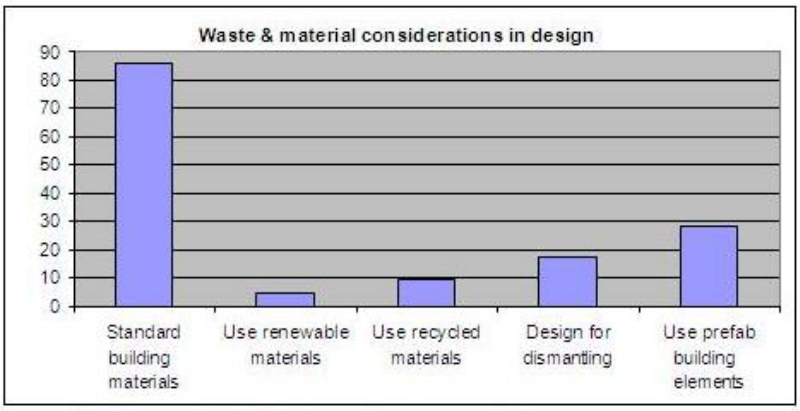

Fig. 3 Waste and materials considerations in design

Construction companies

The construction companies' environmental response is divided into 1) implementation of environmental measures, 2) waste and material considerations on site, and 3) adoption of environmental technologies.

According to the survey's respondents, on 72% of the projects measures are taken to prevent or reduce the environmental impact of material waste. A lot of measures have also been implemented to reduce the occurrence of dust (70%) and noise (57%). See figure 4 for an overview of the implementation rate of more environmental measures.

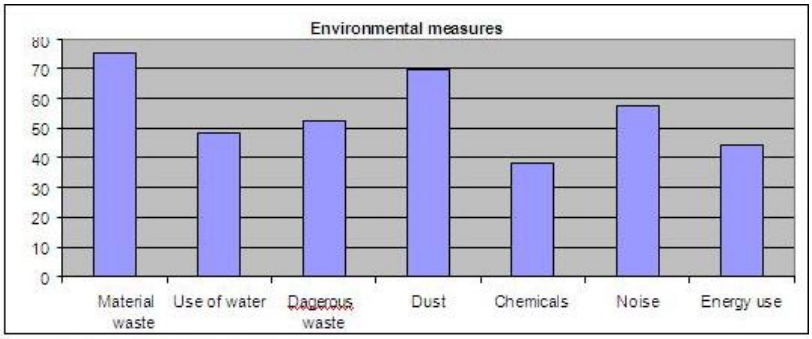

Fig. 4 Environmental actions

Figure 5 shows the degree of waste and material considerations taken in the last three years. In 87% of the projects, no more materials than needed are purchased. The high score for "construction not taking place on the construction site" would suggest that in 57% of the projects assembly of construction materials took place instead of pouring of concrete. As the building construction industry predominately uses concrete and masonry in their work, respondents probably misunderstood this question. Direct reuse of materials on site occurs in 40% of the projects. The separation of waste on site happens in 33% of the cases and prefabricated building systems are used in 31% of the projects.

Fig. 5 Material and waste considerations

Construction companies were also asked whether they have implemented clean technologies to prevent contamination with regard to energy saving, solid waste, noise, dust, and efficient water use. As figure 6 shows, most technologies are dealing with noise and dust. 79% of the respondents implemented at least one technology to reduce dust in the last three years. 64% implemented a technology to reduce noise. Energy efficient technologies are rarely implemented (12%).

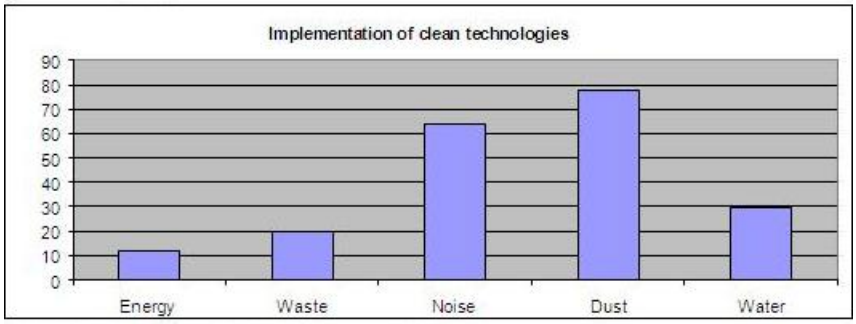

Fig. 6 Application of clean technologies

Asked about the kind of support that would incentive them the most to apply environmental construction practices, both the designers as construction companies mentioned a discount on taxes for companies that invest on sustainability practices as their first choice (31% vs. 63%). The second choice was the direct regulation (48% of the designers and 37% of the construction companies). Figure 8 shows a summary of these opinions.

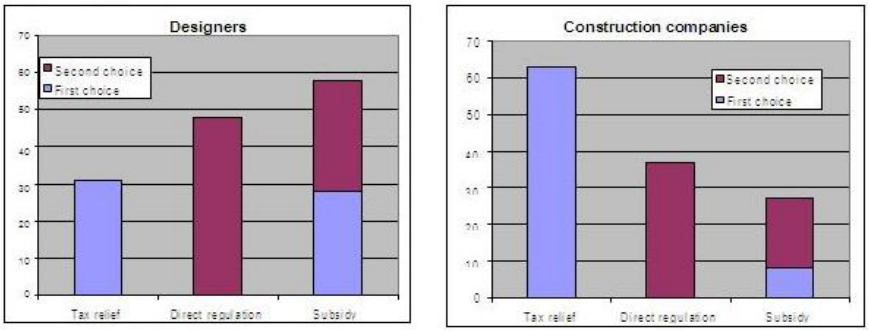

Fig. 8 Opinions on incentives for construction sustainability

Barriers for sustainable construction practices

The top-five barriers according to respondents from construction companies are presented in table 3.

Table 3 Barriers and constraints – construction companies

Barriers & constraints according to construction companies

Top-five	Barrier	Average score of:	Constraint field
1.	Lack of government support	73%	G
2.	Bureaucracy	70%	G
2.	Lack of integral design	70%	T
4.	Price structure does not reflect environmental costs	69%	F
5.	Economic aspects have priority	68%	F

K = Knowledge/ attitude barriers, F = Financial/ market barriers, T = Technology/ process barriers, G = Government/ policy barriers.

The top-five barriers according to the designers are quite similar to the constraints mentioned by construction companies (see table 4).

Table 4 Barriers and constraints – designers

Barriers & constraints according to designers

Top-five	Barrier	Average score of:	Constraint field
1.	Lack of government support	72%	G
2.	Bureaucracy	68%	G
2.	Lack of integral design	66%	T
4.	Focus on investments costs (short-term vs. long-term)	66%	F
5.	Perception of high costs	65%	T

K = Knowledge/ attitude barriers, F = Financial/ market barriers, T = Technology/ process barriers, G = Government/ policy barriers.

Significant difference was found in the opinions of respondents when classifying the design companies by size. In all the cases the small and medium -sized firms (annual operational volume till US$ 5 million) considered barriers as bigger constraints than larger firms do. These barriers are:

- Financial: economic aspects have highest priority
- Technology: lack of knowledge on how to implement sustainable practices
- Technology: lack of integral approach in design
- Policy: lack of government support.

With regard to construction companies, only in one case a significant difference was found between small and medium-sized companies (annual operational volume till US$ 10 million) and big companies. The small and medium-sized firms see a higher barrier in the policy constraint:

- Policy: inconsistency in behavior between different governmental agents

CONCLUSIONS

The government response was measured by means of a desk research and interviews with key-persons from the policy field. The influence of current policy instruments was determined by linking the results of the government response with those of the industry response. The following environmental policy characteristics were determined:

- There is a very narrow coverage of the construction sector in environmental policy. The current legislation is focused only on the construction process and related themes of dust, noise, and solid waste. A start has been made with thermal regulation for the roof design of houses. This regulation has had a positive influence on the industry, resulting in 80-90% application of it.
- In addition, the current legislation is spread over several institutions. No particular organization is responsible for sustainable construction.
- Finally, the policy is focused on direct policy instruments and self-regulation. Indirect policy instruments are almost non-existing in the Chilean environmental policy. The most important example of self-regulation is the Clean Production Agreement (APL). The APL is effective regarding themes that dealt with noise, dust, and waste, but has no impact on a total improvement in environmental construction practices.

The building industry response was mainly determined by means of two questionnaires. The results of this survey indicate the following conclusions:
- The environmental building practices of construction companies are focused on three themes: solid waste, noise, and dust. Waste separation on site and the use of prefab building systems are least often put in practice. By judging the construction companies on an environmental friendliness scale, it can be concluded that 60% of the construction companies consider the environment in less than half of the projects. Only 6% considers the environment in 75% of the projects.
- In general, designers more often take energy considerations into account than waste & material considerations. The orientation of the building to the north and natural ventilation, are mostly considered. Moreover, designing with standard building materials often takes place, which has significantly contributed to a decrease of C&D waste. On the environmental friendliness scale, 42% of the designers operate environmental unfriendly, meaning they consider the environment in less than half of the projects. 6% considers the environment in 75% or more of the cases.
- The discrepancy found in knowledge & interest level versus responsibility level of almost all stakeholders in the construction process, indicates a general lack of interest in and knowledge on how to carry out environmental building practices within the industry.

The most important constraints towards sustainable construction practices include:
- The lack of environmental awareness and knowledge in Chile in general and in the construction industry in particular;
- The lack of government support, especially regarding the small and medium-size design companies;
- The lack of the application of integral designs;
- The lack of assistance in relation to environmental norms and rules provided by government agencies;
- The scarce environmental information available.

Moreover, it was concluded that technological factors do not form a barrier to sustainable construction in Chile. Finally, a mismatch between the industry's vision and the government perception on the constraints towards sustainable construction practices was detected. The key persons in the policy field consider the lack of industry environmental awareness and education as the most important barriers, while the building industry considers the problem to be found in the government policy field.

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