Revisión de la reconstrucción de vivienda patrimonial después del terremoto de Febrero de 2010 en Chile
Review of heritage housing reconstruction after the February 2010 earthquake in Chile

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Resumen

La provisión de vivienda de socorro, después de las catástrofes naturales, es un tema de vital importancia; la necesidad de albergues debe ser solucionado rápidamente para que las víctimas tengan la oportunidad de regresar a sus actividades cotidianas tan pronto como sea posible y permitir una rápida recuperación económica. El diseño de la vivienda definitiva constituye una parte importante del proceso de reconstrucción después de un desastre natural, sin embargo debe considerar el contexto de la historia y factores sociales de una comunidad determinada. Una recuperación de la vivienda que responda a las necesidades de la población de acuerdo a los recursos disponibles y el patrimonio cultural es una prioridad.

Este ensayo analiza las consideraciones del contexto local y patrimonio arquitectónico durante el proceso de reconstrucción, después del terremoto en Chile del año 2010. Los casos de estudio muestran iniciativas de reconstrucción realizadas por organizaciones de socorro, universidades, diseñadores y comunidades. Estos muestran el potencial, pero asimismo las dificultades de reconstruir después de un desastre con el soporte de fondos del gobierno.

Palabras claves: Arquitectura patrimonial, plan de reconstrucción post-terremoto, vivienda de subsidio de reconstrucción.
Abstract

Disaster relief housing after natural catastrophes is a crucial issue; the need for shelters has to be rapidly addressed, so that victims have a chance to return to their daily activities as soon as possible and to allow for a quick economic recovery. The design of permanent housing constitutes a significant part of the reconstruction process after a natural disaster; it should, however, consider the history and social factors in the context of any given community. A housing recovery that responds to the population needs according to the available resources and cultural heritage is a top priority.

This essay analyzes the considerations of the local context and architectural heritage during the reconstruction process after the 2010 earthquake in Chile. Case studies illustrate rebuilding initiatives by relief organization, universities, designers and communities. They show the potential but also the difficulties to rebuild after a natural disaster with the support of governmental funding.

Keywords: City; Architectural heritage, earthquake reconstruction plan, reconstruction subsidy housing.
1. Housing Recovery

Over the past years, the world has witnessed a series of natural disasters that have destroyed the homes of millions of people. A short and not complete list of disasters includes the earthquakes of 1999 in Turkey, 2003 in Iran, 2008 in China (8,000,000 damaged or destroyed homes), 2010 in Haiti (300,000 damaged or destroyed homes), New Zealand (10,000 damaged or destroyed homes), and 2011 in Japan (113,000 damaged or destroyed homes), as well as the tsunami in Sumatra in 2004 (100,000 damaged or destroyed homes), Hurricane Katrina in 2005 (500,000 damaged or destroyed homes), and, and, most recently, Hurricane Sandy in 2012.

Temporary housing after natural catastrophes is a crucial issue; the need for temporary shelters has to be rapidly addressed so that victims have a chance to return to their daily activities as soon as possible and to allow for a quick economic recovery. Naturally, national and international aid first focuses on emergency sheltering. International organizations provide consulting assistance, technical advice, funding, housing solutions, and building materials as relief assistance. Post-disaster reconstruction, however, is a complex process that is subjected to the local context of the affected communities. Organizations, such as the United Nations and the World Bank, provide guidance on post-disaster assistance to effectively direct assistance according to the local possibilities. The United Nations Human Settlements Program (UN–HABITAT), established in 1978, is the UN’s agency for human settlements. UN-HABITAT works in partnership with and in support of local authorities and recognizes the importance of people as main drivers of the reconstruction process, the value of cultural heritage, and the concept of housing as a process and a product in itself (UN-HABITAT, 2010). The design of permanent housing constitutes a significant part of the reconstruction process after a natural disaster; it should consider the history and social factors in the context of any given community. In summary, a housing recovery that responds to the population needs according to the available resources and cultural heritage is, undoubtedly, a top priority.

In most cases, however, permanent housing is ignored at the local community level when planning for disaster response. Architects play an important role in the process of reconstruction because basic shelter needs after disasters turn into built environments for victims and become their social habitat. To achieve user satisfaction, it is necessary to take the victims’ needs into consideration to meet psychological, social and economic expectations. Housing recovery should not only consider available manufacturing and technical building possibilities but also the socio-cultural tradition of the affected area. Users generally refuse reconstruction if it is inconsistent with their own traditions. Reconstruction policies that expend great amounts of money but disregard the cultural context often do not produce satisfactory results; therefore, architects should develop solutions that meet local conditions to improve the temporary and the long-term reconstruction of devastated areas (Tas, Cosgun, & Tas, 2007).

This paper analyzes the considerations (and lack thereof) of the local context and architectural heritage during the reconstruction process through relief housing after the 2010 earthquake in Chile.

2. Housing reconstruction after the 2010 Chile earthquake

2.1. The 2010 Chile earthquake

Chile is situated on the Pacific Ring of Fire, one of the world’s most active seismic regions. On February 27, 2010, a magnitude 8.8 earthquake that lasted 140 seconds hit the coastal region close to Concepcion (Boroshek, Soto, Leon, & Comte, 2010). This earthquake was the worst natural disaster in Chile for the past 50 years with parameters only comparable to the magnitude 9.6 Chilean earthquake in 1960. The earthquake and the subsequent tsunami affected some of the most populated regions of the country. In the first month following the main shock, there were 1300 aftershocks, with 19 in the range of M 6.0–6.9. Estimates suggest that approximately 50 to 100 multistory reinforced concrete buildings were severely damaged and 4 collapsed partially or totally. Lifeline infrastructure generally performed well, given the
magnitude of the event, but failure of some elements led to power outages affecting much of the population for days (Comerio, 2013). The stringent building codes and responsible building practices that have existed since the devastating earthquakes of 1939 and 1960 served to limit damage and saved lives while many older structures were destroyed.

The reconstruction cost is estimated at US$30 billion (Ministerio de Planificación, Ministerio del Interior, Ministerio de Obras Públicas, Ministerio de Hacienda, & Ministerio Secretario General de la Presidencia, 2010). To put the financial cost in context, the reconstruction cost for New Zealand after the Canterbury earthquake in 2010 and 2011 are estimated to exceed US$20 billion (Canterbury Earthquake Recovery Authority, 2012). The New Zealand GDP for 2010, however, was US$32.620 billion, while the Chilean GDP was only US$12.640 billion (The World Bank, 2012) Entire coastal towns and historic districts in the affected areas in Chile were destroyed and the death toll came to 521 people.

2.2. Housing in Heritage Towns and Villages

The affected area of approx. 130,000 square kilometer included more than 900 towns and villages. The area constitutes one of the first areas to be populated in the country and is strongly related to the cultural history of Chile. Among the affected villages were several located in Zones of Historic Conservation or areas with historic heritage value. Cultural heritage value refers to a single building or a group of buildings and public spaces, which express the embedded and collective memory of cultural, environmental and social characteristics. This value encompasses both its cultural and architectural design (MINVU, 2011).

The traditional residential architecture in these areas that had been developed since the 17th century is still common practice. Houses are built using thick earth or adobe walls with timber roofs and clay tiles. Partitions are made of light wood frames, filled with earth. The houses are usually arranged in continuous facades that generate urban corridors. With a distinctive urban layout, these towns are an integral part of the Chilean cultural tradition (Figure 1). During the February 2010 earthquake, more than 370,000 houses were damaged or destroyed; 27% of them were built in adobe. In districts closer to the earthquake epicenter the damage of adobe buildings is considerably higher. In the O’Higgins district 54% of damaged houses were built in adobe while in the Maule district adobe damaged houses reaches 59% (MINVU, 2011). The earthquake had a particularly destructive effect on heritage value villages since the historical houses were those mostly damaged.

2.3 The Heritage Reconstruction Plan by MINUV

Within a few months after the earthquake, a national reconstruction plan was developed, which covered major sectors including infrastructure, hospitals, schools, heritage sites, etc. Housing as a central element of the plan is managed by the Ministry of Housing (MINVU) (Comerio, 2013). MINVU elaborated the “National Reconstruction Programme for Housing: a united Chile builds better” to coordinate the repair and rebuilding of the areas affected by the earthquake. The plan considered actions at city scale, neighborhood scale, and individual housing scale. Based on the post-earthquake survey of damages developed by MINVU, the Plan was rebuilding or repairing 222,000 units for low- and middle-income families. The plan identified different categories of victims and subsidies according to the family income and damage to their houses. Houses with medium or minimum damages were assigned to a repair program that could be managed by the owners or related to a repair subsidy with external assistance from the social housing developer. Destroyed or highly damaged houses were assigned to a housing leasing or subsidy program. A smaller group of families with debt capacity were assigned to a housing leasing or subsidy program. Low-income site-owner families constituted most of the victims supported by the reconstruction plan. These families were given access to emergency housing and a permanent housing subsidy. Families that did not own the property where their house collapsed were assisted with emergency housing and relocated to permanent housing on new sites.

The housing subsidy program was based on the existing Chilean social housing program with some modifications. Thus, the Chilean government adapted existing programs rather than develop new programs (MINVU, 2011) aimed to provide safe and efficient reconstruction. Comerio identifies the history of experience in improving housing conditions by the Ministry to respond to housing needs as one of the crucial...
elements in the success of the reconstruction process in “Housing Recovery in Chile: A Qualitative Midprogram Review” (Comerio, 2013).

Of the 222,000 homes assigned for government assistance, repairs of damaged homes considered 106,000 houses while 116,000 needed to be rebuilt. The Reconstruction Plan set the completion deadline for February 2014; however, according to the report on January 2014 only 91,797 (79%) of new homes had been delivered. Most of the solutions consisted in diverse prefabricated models of single-detached dwellings each owner could choose. The houses do not correspond to the type of urban housing in centers with compact units with constant buildings heights, continuous facades and roofs. The provided houses fit the requirements of delivery and timing but they do not recognize specific contexts or housing grouping that conform to existing urban landscapes (de la Cerda, 2010).

In May 2011, MINVU launched the “Heritage Reconstruction Plan” that aimed to repair and rebuilt homes in heritage areas of the affected districts by maintaining traditional features and values that give identity to existing historic towns. The purpose of the plan was to respond specifically to the basic needs of the communities and existing architectural values in each of the villages, thereby rescuing their social networks and traditional identity. Among its key points, the plan considered the earthquake as an opportunity for development and changes on public policies; it fostered working with local resources such as traditional building materials. It also considered recognizing the communities and local stakeholders as well as public-private cooperation as active participants in the process. In addition, the plan identified the need to review traditional building techniques as a fundamental aspect.

Besides historical buildings such as churches and public buildings, the plan considered rural housing as an important cultural heritage element as it represents the way of living that reflects the history and customs of the area. To maintain the architectural character of the villages, developers were highly encouraged to follow the local architectural typology that could adapt to the particularities of the historical context; the allocation of homogenous housing design should be avoided. While emergency housing is important as a temporary solution, architectural heritage requires specific long-term treatment.

The plan was developed through the stages of diagnosis, analysis, strategies, projects and implementation. The diagnostic stage, after a survey and data compilation, defined 68 heritage areas composed of areas previously defined by the National Monuments Council and new areas of heritage interest incorporated in local master plans or defined by local entities after the earthquake. The analysis stage identified 13 heritage characteristics of the affected areas to be considered in the reconstruction process. The list recognized architectural aspects such as volume and architectural expression, the vertical orientation of openings and facades mainly composed by opaque walls. Urban design aspects included were roofs and corridors as part
of the public space and continuous facades the whole width of a site. Regarding architectural aspects, the analysis also noted the lack of specialized architects in heritage reconstruction as one of the challenges. The construction considerations included the use of concrete or stone bases and building systems such as adobe and its characteristic wall thickness. However, the lack of a building code for adobe structures was identified as one of the main issues in the reconstruction process.

The implementation stage considered the set up of heritage technical work teams in the affected areas, an open call for professional teams to develop reconstruction projects and training sessions related to cultural heritage and traditional building techniques. The participation of local residents was also considered through the development of dissemination materials, workshops and site visits.

The financing method was based on the programs developed by MINVU housing subsidies with a basic benefit of U.S. $ 15,000. However, the Heritage Reconstruction Subsidy granted an additional benefit of U.S. $ 8,500 over the basic benefit. As a result, heritage reconstruction housing had a budget 60% higher than conventional housing reconstruction. The plan also highlighted specific projects that met the objectives. The selected projects were the Heritage Recovery Plans in Paredones by Tarapaca Project, in Sauzal by Friends of Sauzal and in Cobquecura by Cooperation German GTZ.

2.4 Proposals by Architects and the 2010 Venice Biennale

The reconstruction after the earthquake was a great challenge for local architects. After the demand for emergency housing was quickly covered mainly by the joint action between the state and private enterprises the problem of long-term reconstruction became relevant. Local architects also identified that emergency housing and prefabricated housing proposed by the government responded to an autonomous configuration with low-density schemes and rigid use patterns but did not suit the particular needs of urban heritage centers. This situation was an opportunity for architects to develop groundbreaking projects in restrictive conditions defined by low costs, shortage of resources and management difficulties. As pointed out by De La Cerda, designers were forced to analyze the historical forms and to consider contemporary demands in each emergency context. The combination of these design factors required distinct but not necessarily exclusive inputs (de la Cerda, 2010).

The Chilean exhibition for the 12th International Architecture Exhibition at the 2010 Venice Biennale featured projects designed by architects and universities related to the reconstruction after the earthquake of the same year. The selected projects showed possibilities of architecture to anticipate and project new ways of living, not only as architecture of emergency but in reconstructing the cultural heritage and by transforming an emergency into an opportunity (Cruz-Coke Carvallo, 2010). Thus, the exhibit was structured according to: a) the projects related to prefabrication methods, b) organizations involved in the process and c) reconstruction of cultural heritage.

The Cultural Heritage section gathered those works that use traditional building systems and propose an architectural research that rescues the expression of the built environment with classical urban forms such as the street corridor, the sloping roof, the gallery and the inner court (Cortés, 2010). Heritage reconstruction featured projects including the reconstruction of the street corridor of the village of Pumanque by Colectivo Muro, and that of the town of Curepto by Lira, Rodríguez and Arroyo.

Reference to the project by Lira, Rodríguez and Arroyo also can be found in “Earthquake in Chile: Architects in the Reconstruction” by the Association of Architecture Offices (AOA) detailing the work done by association members in parallel with government projects. The publication features designs for schools, fishing villages, 8 models of houses. However, only a single project related to the recovery of cultural heritage is included (Asociación de Oficinas de Arquitectos de Chile, 2011).

3. Reconstruction Periods and Case Studies

The plan by the government set a 4-year period to complete the housing reconstruction process in the affected areas. This deadline has been met; the outcome of projects related to heritage reconstruction can be evaluated. Featured projects in the Heritage Reconstruction Plan and the Chilean exhibition for the 2010 Venice Biennale can be analyzed to determine the results of the proposed design strategies. These projects
were recognized by the government and architects’ organizations in the early stage of the reconstruction as outstanding designs that meet the expected standards for heritage recovery.

The featured projects are located in Paredones, Curepto, Pumanque and El Sauzal. These locations were founded in the mid-eighteenth century and are prominent examples of towns featuring vernacular architecture in adobe. All these towns were severely affected by the 2010 earthquake (Figure 2). After the earthquake, heavy equipment was used in Curepto and Pumanque to remove the debris and demolish damaged buildings. Bulldozers razed the uninhabitable buildings indiscriminately, damaging the adjacent ones and totally destroying those still recoverable (Gray, 2010).

The heritage recovery projects for the above mentioned locations were separately developed by teams of architects, nonprofit organizations and government agencies. All proposals count on the active participation of residents either through informative meetings or through project management. Despite the fact that all projects were developed separately, the formal solution of these proposals is very similar; they have various design aspects in common (Figure 3).

Architects recognized that the prefabricated single-detached dwelling solution proposed by the government did not meet the urban conditions of the destroyed towns. Therefore, the designs proposed housing that intended to foster the urban layout and character of the locations. Designs also identified heritage design features from traditional architecture that they incorporated into their proposals. The continuous façade with a public corridor and a street corridor was used as the design strategy to rebuilt landmarks of architectural heritage. The traditional continuous façade wall separates the public space from the private lots; a gabled roof protects both. Consequently, the reconstruction of houses was considered from an urban perspective.

The projects had to meet the social housing requirements defined by the government in order to be eligible for subsidies. These requirements cover a wide range of aspects including design conditions and restrictions for the units, construction standards as well as the qualifications and responsibilities of the professionals involved in the process.
Among the design requirements for the subsidy houses were size constraints: houses should have a built area of 50m² with 2 bedrooms and 1 bathroom. However, this layout does not correspond to the heritage homes of the affected areas with a larger built area and larger rooms. As a result, many owners were not able to fit their furniture in these new houses. Aware that the model did not correspond to the owners’ requirements, architects proposed expansions.

Among the agents involved in social housing development, the Social Housing Management Entity (EGIS) is of central importance. EGIS is an entity (i.e. organizations, contractors, real states or municipalities) with a previously signed agreement with the Housing Ministry to provide technical and social assistance for the social housing program. Each EGIS group is responsible for developing and submitting projects for approval so that they are technically and economically feasible and code compliant. EGIS is also in charge of the construction management and execution of building projects.

The social housing subsidy and the patrimonial reconstruction subsidy considered approximately US$23,500 per project. However, after the first cost estimates designers realized that this amount was not sufficient. Therefore, architects developed alternative strategies to fit the proposed designs within the available budget. In some cases, owners were also eligible for other funds such as subsidies for local initiatives or retail development. These options required a much easier application processes; funds were awarded in advance and did not required the management by EGIS. As a result, many owners were able to rebuild faster but with houses that did not correspond to heritage considerations.

Adobe is the traditional local building material. However, it is not regulated by the current Chilean building code. Previously, adobe-structured buildings were not supported by reconstruction subsidies. Other building systems consistent with the building code were proposed to meet requirements. Most built cases were structured in masonry walls (with a bracket-shaped plan layout to simulate the thickness of traditional adobe walls).

In summary, each project consisted of a particular proposal that responded to patrimonial design, budget, location and owner needs. This strategy does not correspond to the mass production standards of social housing.

3.1 Case Studies

3.1.1 Heritage Recovery Plan in Paredones by the Tarapacá Group

The Tarapacá Group is an initiative lead by graduate students from the Catholic University of Chile that addresses the reconstruction of heritage towns after the 2005 earthquake in Northern Chile. Their work had been carried out to identify heritage values together with local communities. After the 2010 earthquake, the Tarapacá Group developed a project in Paredones[20] where the architects previously had...
worked with the municipality. One of the most interesting features of the proposal is its building system that emulates the thickness of traditional walls by combining a timber frame structure with blocks of thatch as insulation and recycled adobe as exterior and interior finishing (Figure 4).

The original proposal considered 8 houses. EGIS discarded the development of the project due to economic difficulties. Among the technical requirements, each detached house required a separate site management. As a result, operating costs were too high for a small number of houses. One owner of a house/store applied on his own for a commerce development subsidy using the heritage reconstruction design. This subsidy granted a similar amount of money in advance and did not required management by EGIS. With the proper professional guidance and without intermediaries, the owner built the house/store by himself and made modifications to the design according to his own considerations. In this particular case in Paredones, the owner modified the timber frame structure with blocks of thatch for masonry due to the presence of termites.

3.1.2 Reconstruction System in Curepto by Raimundo Lira, David Rodríguez, Diego Arroyo, Rocío Costa and Álvaro Schwember

The Mustakis Foundation is a private organization with a mandate to promote culture and education. This organization contacted Raimundo Lira Architects within a few days of the 2010 earthquake asking for reconstruction strategies for the affected towns. The architects designed a long continuous façade in the main street of Curepto. The proposal consists of a two-story central volume onto with an attached exterior corridor and an interior expansion module. This approach makes it possible to match the proportions, dimensions and heights of the typical buildings of the area. The two-story volume allowed mixed-use on different levels. The commercial programs and the sanitary module were to be available on the street level; the proposal also considered residential housing use on the first floor. Later, after briefings with owners, each house design was individually refined to incorporate particular design requirements (Figure 5).

The project proposed a financing scheme that considered private funding for the corridor and public funding for the roof and the private sanitary modules. Under self-construction methods, families would finish the house and built future expansions. The proposal originally considered 35 houses and architects submitted 12 building permit applications. However, EGIS discarded the project due to economic infeasibility for similar reasons presented in Paredones, and later two other private contractors failed to meet the deadlines. With no feasible alternative to the base module, the project for the public corridor funded by private entities was never started.
Thus, the owners were forced to manage the reconstruction on their own, and today several houses are under construction on Curepto’s downtown that are under self-construction management. Heritage designs have been partially followed according to considerations from the owners themselves, some solutions incorporated a corridor in their final designs but others did not.

The house of Ricardo Rojas is the only case built through the heritage reconstruction subsidy. He applied individually for benefits and managed the project himself. After unsatisfactory experiences with two EGIS, he signed an agreement with a private contractor setting deadlines and penalties in case of delay. Although the house was built according to the heritage reconstruction proposal, the corridor was eliminated from the design due to budget cuts. In addition, the owner admits that the process was complicated and time consuming. After four years, he opted to receive the house with basic finishes in order to conclude the renovation process independently.

3.1.3 Pumanque Wall by Colectivo MURO

Colectivo MURO was created after the earthquake by a group of architects that contacted the Municipality of Pumanque. Pumanque was one of the heritage towns that were significantly damaged. The municipality commissioned the group the reconstruction project for the damaged houses. As reconstruction strategy, Pumanque Wall consists of a wall that separates public space from private realms; it constitutes a recognizable facade which openings of doors and windows with typical proportions (Figure 6).

Despite the available subsidy’s economic constraints, architects decided that the available budget should finance all three: the house, the division wall and public corridor. To limit costs from building materials, they decided to repair the areas of houses in better conditions and reuse recovered elements such as windows or columns. Only in cases of total destruction a new house was required.

In summary, each house was individually evaluated and designed to fit the subsidy’s budget according to one of the three typologies: newly redesigned and rebuilt houses, houses built with reused elements or repaired houses.

However, the custom design and permit approval periods for the projects took longer than originally expected. Currently, 10 houses have been built while 30 units were considered in the original project. It is expected that the remaining houses will be completed by the end of 2014.
3.1.4 Heritage Recovery Plan in El Sauzal by Universidad Mayor.

Grupo de Amigos del Sauzal was created immediately after the earthquake by neighbors, family members and people connected with the town. One of the main concerns of the organization was the reconstruction of the town. The group contacted the Faculty of Architecture from Universidad Mayor in Santiago to conduct a survey and to design proposal for the village.

As a first response, the university conducted a damage survey of the buildings in the town and designed reconstruction projects for public spaces. For the reconstruction of urban housing, a group of professors proposed 3 models of houses preserving the local architectural heritage elements. One model dealt with a house on a corner and two models proposed houses between party walls. In a later stage, each project was individually redesigned incorporating geographic considerations; the house designs had to be adapted to the steep slope of the town.

This project considered a financing scheme similar to that of social housing. The design used the reconstruction subsidy as the only financing source with no participation of private organizations or self-construction by the owners. The original proposal considered 200 units with an economy of scale that allowed an EGIS to manage and build the project without encountering the economic feasibility issues of the previous cases.

However, the project experienced setbacks due to building permits delays and slow administration from government entities that resulted in partially finished projects.

3.2 Analysis

3.2.1 Built Results

None of the featured projects of the originally considered units were completed within the 4-year reconstruction. In El Sauzal and Pumanque, 35% from the originally planned houses were completed. The most efficient case is El Sauzal with 70 built homes while in the cases of Curepto and Perdones only one home was built through self-management from owners. In all cases, the built area and architectural designs were similar. However, the results were radically different. The projects specified different structural systems; the most successful cases considered masonry that is more expensive than timber structures (Table 1). The reasons for the level of completion cannot be solely analyzed through parameters of architectural design.

The heritage reconstruction process in the described cases is still incomplete; the reconstruction of the identity of the towns proposed in the original projects using continuous facades and public corridors is not yet finished. Isolated houses cannot
conform to the profile of the street. However, when built they define design guidelines and references for the following housing to come (Figure 7). Unfortunately, there are no concrete plans to ensure a heritage focus in the future due to the lack of long-term vision of the government. Currently, local authorities from the featured towns have not developed patrimony reconstruction policies and patrimony standards. No urban plans or long-term reconstruction strategies have been approved from the local municipalities.

3.2.2 Management based on the Social Housing Subsidy

The featured case studies represent independent efforts to respond to the urgent need for provide housing. Local governments, groups of neighbors and architects got organized to safeguard the heritage features of destroyed locations. Participants often had no previous experience in heritage reconstruction. The diversity of participants resulted in various design proposals that were developed independently. Despite this fact, architectural designs are very similar while the financing strategies are very different. In all cases, the financing schemes for reconstruction plans were based on the existing social housing subsidies. The differences depended on ways to incorporate parallel resources to benefit from government support (Table 2).

Overall, the government made no significant changes to the social housing subsidy structure when applied to the earthquake and tsunami reconstruction. Government support did not have the flexibility to adapt to the alternative financing proposals from the designers.

Figure 6: Pumanque Wall project. Source: [Gray, 2010] (reprinted with permission)

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<th>Paredones</th>
<th>Curepto</th>
<th>Pumanque</th>
<th>El Sauzal</th>
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<td>35</td>
<td>30</td>
<td>200</td>
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<td>Built (Units by Feb 2014)</td>
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<td>1*</td>
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<td>70</td>
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<td>Completion Rate</td>
<td>13%</td>
<td>3%</td>
<td>33%</td>
<td>35%</td>
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Table 1: Originally proposed homes and built homes by February 2014.

*Houses built by self-management from the owners.
Figure 7: Heritage Reconstruction Subsidy Housing in Paredones(1), Curepto(2), Pumanque(3) and El Sauzal(4). Reprinted with permission. Sources: Bernardita Devlat (1), Ricardo Rojas (2), Umberto Bonomo (3), Jorge Hoehmann(4)

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Table 2: Proposed financing strategies for heritage reconstruction projects.

The social housing subsidy has proven to be effective for the development of massive housing. A similar situation can be noted in the case of El Sauzal where the management strategy fit the chosen model. The 200 houses considered in the project allowed matching the subsidy’s amount to the budget, sharing on-site administration cost among all houses. The other case studies considered between 8 and 30 houses, and on-site management costs were too high to be developed according to the subsidy’s requirements. The proposal for Curepto incorporated private funding at a later stage to finance the public corridor as one of the main heritage elements of the town. However, the restrictive requirements of the reconstruction subsidy could not be adapted to the proposed financing system. The mixed financing scheme in various stages was not specified within the subsidy and, despite the interests shown by local communities, the project was not completed. The strategy used in Pumanque resulted in a more effective application of a customized design for each unit according to the available resources, reusing constructions elements, recycling building materials and repairing the less damaged units. This strategy required much more design time and could only be fulfilled through the volunteer work of the architects involved that is not considered in the costs of the subsidy.

The subsidy certification process was also slow and complicated. The ownership-related paperwork required for the application was difficult to meet due to the age of the damaged houses. In many cases, there was no clarity about ownership due to heirs that could not be identified or documents that were not up to date. Most of these drawbacks were solved thanks to flexible policies from the legal system. However, they contributed to delays in approval periods.
Building permits in Pumanque took over 6 months due to the lack of government officials in the affected areas. As no qualified assistance was available on-site, all applications were processed by the Housing Ministry in Rancagua. This resulted in an extremely long period for processing.

Overall, the reconstruction process was carried out by a multiplicity of agents instead of a single organization in charge of design and management. The required coordination and customized designs applied to a non-flexible subsidy program resulted in only partially completed cases.

3.2.3 The Role of EGIS

Among the involved agents in the process, EGIS was very relevant. Government subsidies required that construction must be managed by an EGIS. In the case studies, EGIS were acting as small contractors. In addition, municipalities, which develop social housing, had no previous experience in heritage projects. Also, it is important to consider that the government granted the payment of the benefit only by completion of the units. The management in El Sauzal was very close to the social housing model and allowed the involved EGIS to match the subsidies with expected administration costs. In the cases of projects with fewer units, on-site administration costs were too high compared to standard social housing.

Most EGISs were not able to absorb the costs of the delayed funding availability. As a result, they lost interest in non-standardized projects such as heritage housing reconstruction. This situation left a void in the organization of the subsidies that could not be filled by another entity (e.g. contractors that were not registered as EGIS) or developed in an alternative way (e.g. self-construction). This was the central point in the failure to complete the projects in Paredones and Curepto.

3.2.4 Self-construction

Reconstruction subsidies were tailored to the social housing program. In many cases, the profile of the owners did not fit the profile of social housing applicants. Many of the damaged houses were second houses, and the owners had some financial resources for the reconstruction. However, they could not complement the government subsidies with their own private funding due to regulations. Some of the residents were also not familiar with the heritage value of their towns. In addition, delays in the reconstruction process encouraged owners to choose prefabricated houses from the government, leaving aside the heritage reconstruction projects. Others more concerned about the heritage value of their homes applied for funds with a simpler application process. These funds required no participation from EGIS, granted the money in advance and allowed to complement subsidies with private funding. In the cases of Paredones and Curepto, only one house was rebuilt according to the heritage design proposal under the management of the owners. However, due to a lack of regulations, owners were free to modify the design according to their own considerations. In these cases, the design of the public corridor and the structural systems were altered due to practical considerations of cost-savings and fire-safety concerns.

4. Conclusions

Traditional housing recovery is a vital aspect to restore the cultural tradition in the reconstruction process after the 2010 earthquake in Chile. Various agents have shown a particular concern and active participation in the process. The Chilean government, relief organizations, universities, designers and communities responded with proposals shortly after the disaster. The government developed a heritage reconstruction plan that analyzed the architectural value of the affected areas, defined the subsidy standards and granted a bonus to support the implementation of the design proposals. Designers and universities developed design proposals according to the identified heritage values and considered user participation from the affected communities in various phases of the process.

The implementation phase of the projects lacked specific heritage housing protocols. As a solution, the government attached the heritage reconstruction plan to the social housing subsidy. This strategy had significant implications for the proposed reconstruction. Unfortunately, the subsidy guidelines by the government made many projects unfeasible because it did not consider self-construction, parallel funding or alternative building systems.
Flexibility in the requirements of heritage reconstruction strategies is crucial to streamline the reconstruction processes. Effective communication between regulators and designers is also necessary to prevent loss of resources and lack of coordination.

The most successful outcomes are projects able to adapt to social housing standards; this is possible mainly because of the economy of scale of the proposals. The affect of these cases on the ongoing reconstruction process of the local architecture and urban layout still needs further research. Projects with fewer units can be sensitive to existing urban conditions but do not meet the management strategy of the government reconstruction scheme. It is necessary to develop a strategy of “micro-reconstruction” that fits heritage-housing recovery at a small scale. This strategy could then also be adapted to similar cases in other natural catastrophes.

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