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Re-thinking Elemental's incremental housing: Residential Satisfaction and resident-driven adaptations in Villa Verde, Chile

Repensando as moradias incrementais da Elemental: satisfação residencial e adaptações voltadas para os residentes em Villa Verde, Chile

Repensando la vivienda incremental de Elemental: Satisfacción residencial y adaptaciones impulsadas por los residentes en Villa Verde, Chile

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Abstract

The Elemental architecture studio designed Villa Verde, one of the world's most iconic incremental housing projects. Villa Verde was initiated to house residents of the city of Constitución in southern Chile under a participative framework. The aim was to encourage the residents to complete the "other half" of the "core" houses supplied by the developer, self-managing a process of housing modification and extensions to suit their needs and aspirations. This paper analyzes the residents' perceptions and the incremental additions to the 'half-houses' built in the four years since the occupation and identifies the factors that influenced these adaptations. The analysis focuses on the relationship between the changing residents' satisfaction levels and the subsequent housing adaptations. This study demonstrates that residents' self-managed housing adaptations were performed according to financial capacities and individual aspirations with more than half of them built beyond the design limits. The self-help constructions followed a variety of formal and informal patterns demonstrating that the incremental process had an initial momentum that decreased as the residents' needs were covered, but it is likely to continue and take on unpredictable and more complex forms that could impact the neighborhood management, inclusive governance, and financing of future adaptations.

Keywords: Elemental. Villa Verde. Incremental housing. Residential satisfaction. Resident-driven adaptations.

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Resumo

O estúdio de arquitetura Elemental projetou a Villa Verde, um dos projetos habitacionais mais icônicos do mundo. Villa Verde foi iniciada para abrigar moradores da cidade de Constitución, no sul do Chile, em um quadro participativo. O objetivo era encorajar os residentes a concluir a "outra metade" das casas "centrais" fornecidas pelo incorporador, autogerenciando um processo de modificação e ampliação de moradias para atender às suas necessidades e aspirações. Este artigo analisa as percepções dos residentes e as adições incrementais às "casas de meia" construídas nos quatro anos desde a ocupação e identifica os fatores que influenciaram essas adaptações. A análise enfoca a relação entre os níveis de satisfação dos residentes em mudança e as adaptações habitacionais subsequentes. Este estudo demonstra que as adaptações habitacionais autogestionárias dos moradores foram realizadas de acordo com as capacidades financeiras e aspirações individuais, com mais da metade delas construídas além dos limites do projeto. As construções de autoajuda seguiram uma variedade de padrões formais e informais, demonstrando que o processo incremental teve um impulso inicial que diminuiu conforme as necessidades dos residentes eram atendidas, mas é provável que continue e tome formas imprevisíveis e mais complexas que podem impactar o gestão de bairro, governança inclusiva e financiamento de adaptações futuras.

Palavras-chave: Elemental. Villa Verde. Habitação incremental. Satisfação residência. Adaptações dirigidas aos residentes.

Resumen

El estudio de arquitectura Elemental diseñó Villa Verde que es uno de los proyectos de vivienda incremental más icónicos del mundo. Villa Verde se inició para albergar a los habitantes de la ciudad de Constitución en el sur de Chile bajo un marco participativo. El objetivo era animar a los vecinos a completar la "otra mitad" de las viviendas "núcleo" suministradas por la promotora, autogestionando un proceso de modificación y ampliación de viviendas a la medida de sus necesidades y aspiraciones. Este artículo analiza las percepciones de los residentes y las adiciones incrementales a las 'en la otra mitad' de las casas construidas en los cuatro años desde la ocupación e identifica los factores que influyeron en estas adaptaciones. El análisis se centra en la relación entre los cambios en los niveles de satisfacción de los residentes y las posteriores adaptaciones de la vivienda. Este estudio demuestra que las adaptaciones de viviendas autogestionadas de los residentes se realizaron de acuerdo con las capacidades financieras y las aspiraciones individuales, con más de la mitad de ellas construidas más allá de los límites del diseño inicial. Las construcciones de auto gestionadas siguieron una variedad de patrones formales e informales. El artículo demuestra que el proceso incremental tuvo un impulso inicial que fue disminuyendo a medida que se cubrían las necesidades de los residentes, pero es probable que continúe y tome formas impredecibles y más complejas que podrían impactar el gestión vecinal, gobernanza inclusiva y financiación de adaptaciones futuras.

Palabras clave: Elemental, Villa Verde, vivienda incremental, satisfacción residencial, adaptaciones impulsadas por los residentes.

Introduction

The exponential effects of global population growth and rapid urbanization have created inadequate, inequal cities where adequate and affordable housing is unachievable for the poor and marginalized. Despite the global commitments such as the New Urban Agenda and the Sustainable Development Goals, the urban population living in slums have risen to 24% in 2018 (United Nations, 2020). The conventional government housing schemes have been widely criticized as they fail to address the poor's housing needs and create further inequalities and exclusion (Ducci, 1997; Marinovic, 2020). Providing alternatives to

engage the people as collaborators in the co-design and co-production of housing has been widely discussed since mid-twentieth century especially in the global South.

Latin America was the first region in the global south to experience rapid urbanization and is the birthplace of approaches legitimizing the self-help housing strategies common among the urban poor (UN-Habitat, 2011). From the late 1950s a range of architects began rethinking people's role and advocating for alternative of promoting self-construction to combine residents' spontaneous initiatives to formally designed and built frameworks (O'Brien et al., 2020). Turner and Fichter (1972) with their book "Freedom to Build" reflected on the informal resident-driven housing construction process commonly seen in Peru. Turner's ideas later highly influenced the housing policies in Latin America as they claimed that housing is "more a verb than a noun" as it impacts the people's social and economic wellbeing. International agencies endorsed these strategies such as the World Bank and the Inter-American Developing Bank, responding to the high housing deficit in the region and assisting the transition from informal to formal settlements (Mora et al., 2020). Developed in parallel with Turner's ideas, the Dutch architect John Habraken in his book "Supports" proposed a support structure that residents would infill as they might have the control and fit-out of their dwelling (Habraken, 1972). In the following decades, the discussion about the advantages to rethink housing policies and support incremental schemes extended globally as one of the most efficient ways to address economic sustainability whilst still responding to some of the residents' aspirations (UN-Habitat, 2016). Nohn and Goethert (2017) research claim that incremental construction is the largest viable creator of new affordable housing worldwide.

Self-built incremental housing production has remained the oldest and most pervasive form of affordable housing (O'Brien et al., 2020). Thus, encompassing the co-existence of formality and informality where the people's self-help initiatives are intensified by the existing housing inequalities (Iveson et al., 2018). The frequently tense government-people relationships caused by inequalities, marginalization and exclusion create conditions for the poor to take decisions that defy the status-quo of distant power and address their own needs (Holston, 2008) and emerge through insurgent practices (Miraftab, 2009) that are not limited to the self-help housing construction but can scale-up to the development of their own city (Choguill, 1999; Jankowski et al., 2019).

In the early 2000s, there was a surge of criticism of Chile's conventional social housing programs due to the houses' poor quality and reduced areas (Rodríguez & Sugranyes, 2004; Muñoz, 2007). The demands for policy change included a switch towards more participative schemes of housing subsidies that encouraged experimental and innovative projects for the poor (Arriagada et al., 2004). Chilean experiences in incremental housing projects influenced the resurgence of people-oriented practices seeking to address the housing inequality legacy of the Pinochet era (Halloran, 2020).

In 2003, Habraken and Turner's ideas were revisited by the Chilean studio Elemental, led by Alejandro Aravena, the Pritzker prize winner in 2016, aiming to address the housing deficit for the poor using the existing government schemes of housing subsidies available to build a 'half good house' (Aravena, 2014). In 2005, the first Elemental-designed incremental housing project Quinta Monroy was completed in the northern Chilean city of Iquique. This project was a slum upgrading housing project that combined the use of reduced land and tight budgets with a design that provides a structural framework to be infilled by the residents and became one of the most iconic incremental housing projects globally. In the following years, 2,045 Elemental-designed houses were built in Latin America and inspired global discussion about co-production of housing projects, people's capacities for self-development but also sparked criticism about how such project might also create further inequalities (Boano & Vergara Perucich, 2016) and how this might impact housing policies and rampant issues such as affordability in countries in the global South and North (Halloran, 2020).

Therefore, this study aims to contribute to the discussion on housing appropriateness by analyzing incremental housing projects designed to be expanded from the residents' perspectives, such as the Villa Verde housing project. Analyzing residents' perceptions about the initial housing and the drivers for extending them provides a valuable insight into the complexities embedded in the gradual change of their built environment. Furthermore, this study focuses on residents' agency in the incremental

developments in the four years of occupation and identifies the factors that have governed these changes. The findings will provide insights into how incremental housing connections to a complex and broader system of city-making in the global South might influence pathways for incremental urban development, as Van Noorloos et al. (2020) claim.

Incremental housing experiences in Chile

In the 1950s, an agreement between Chile and the United States promoted self-construction approaches to implement housing programs acknowledging the residents' capacities (Arriagada et al., 2004; Greene, 2004). During the 1960s, additional programs incorporated participatory approaches to address the housing demand (Arriagada et al., 2004), halted in the 1970s until 1990 (Mora et al., 2020), when the Pinochet's regime in Chile prioritized quantitative approaches and fully-built houses. Further evaluations evidenced the 'dark side' of a successful quantitative housing policy (Ducci, 1997) and the emergence of the 'people with a roof' problem regarding the homelessness experienced by beneficiaries of inadequate housing (Rodríguez & Sugranyes, 2004). In 1990, with the implementation of the 'Progressive Housing Program' government housing subsidies included the financing of core houses' extensions (Arriagada et al., 2004). Since 2001, the government implemented the Housing Solidarity Fund promoting participative approaches for the involvement of the beneficiaries and their physical and social integration in the neighborhood (MINVU, 2005). Between 1990 and 2019, the Chilean government granted 1.14 million subsidies for the most vulnerable families in the country (MINVU & Observatorio Urbano, 2019). In addition, since 2004, the Chilean government provided subsidies for housing extensions which could be applied in tandem with previously granted housing subsidies. In parallel to the changes in the housing policies in Chile, innovative housing projects became milestones for the development of incremental housing. As an example, the 'Comunidad Andalucía' was built in 1992 in the center of Santiago. The project's design encouraged the extension of the liveable spaces inside a 'shell-like' structure (Arriagada et al., 2004).

In early 2000, Elemental's 'half-good house' strategy became a milestone of flexibility and residents' co-production principles. In 2003, the Elemental team was appointed to develop the social housing project at Quinta Monroy. Positive reporting of that initiative, documented in the media and by Elemental themselves, encouraged the Chilean resource company, Arauco, to commission Elemental to design 'Villa Verde', an estate planned from 2009 to house timber workers and families in the city of Constitución in southern Chile under the Housing Solidarity Fund program.

Research design

This paper analyses the residents' current housing conditions at Villa Verde, investigating efforts to improve their housing and their motivations for housing extensions and improvements. It does this by recording the residents' attitudes – expressed via their satisfaction levels – and compares this over a four-year timeframe from pre to post-occupation.

Incremental housing schemes and policies have been studied and implemented in various countries, particularly in the global South. Therefore, to contextualize this study, the data analysis considers the key findings of evaluations conducted through former Chilean housing programs such as Sites and Services (Sepúlveda, et al., 1994; Sepúlveda, Muñoz, et al., 1994), Progressive Housing Program (Mora et al., 2020), and Housing Solidarity Fund (Andrade, et al., 2007; Olivera et al., 2012). Additionally, the residential satisfaction analysis in Villa Verde is based on the framework developed by Andrade, Aguirre, and Mora (2007) which targets housing complexes developed under the Housing Solidarity Fund.

Furthermore, the complexities behind residential satisfaction and residents' motivations and decision-making (Doyle, Brady, & Byrne, 2009) in Villa Verde require a mixed research methodology combining quantitative and qualitative analysis. The analysis of quantitative information will provide the

empirical validation of the situation and trends found in Villa Verde, considering the residents as a group. In contrast, the qualitative analysis of the information collected through interviews will understand the residents' perceptions and behaviors at the individual level.

Sample and participants' selection

The data was collected between July and August 2017. The initial contact with the community was through community leaders. Currently, in Villa Verde there are two neighborhood associations. The most active is 'Las Gardenias' (Figure 1) and the research was introduced to the residents during a community meeting with residents from 'Las Gardenias' in middle July. During this event, 40 residents agreed to undertake the questionnaire, among them 19 agreed to be interviewed in the following days. Later, an additional 13 interviews were conducted completing 32 interviews. The questionnaire participants were randomly selected. The details of the tools used for data collection are detailed below:

- 1) A closed question quantitative questionnaire seeking (a) general household data, (b) previous housing conditions, (c) initial conditions at Villa Verde, and (d) current housing conditions.
- 2) Qualitative, semi-structured interviews, extending data gathered by questionnaire to include (a) timelines for incremental additions, (b) difficulties encountered when undertaking incremental improvements, (c) future plans for improvements and (d) changes to the broader neighborhood.
- 3) Mapping of settlement conditions using architectural research tactic including architectural drawings, photographic surveying and physical trace analysis (Zeisel 1984; Groat & Wang 2002; Yin, & Campbell 2018).
- 4) Secondary data from government reports, books, and academic papers.

Scope and limitations of the study

The participant residents were mainly from 'Las Gardenias' with the endorsement of community leaders to this study. Lower levels of leadership from the 'Comite 1' led to reduced interest in the study from those residents.

The research framework developed by Andrade, Aguirre, and Mora (2007) and Andrade, Aguirre, Mora, et al. (2007) divide the residents' perception of home and environment into three levels: Micro-level or house, Meso-level or neighborhood, and Macro-level or housing complex. This study focuses mainly on the analysis of the Micro or housing level. Previous studies about incremental housing in Chile (Sepúlveda, Muñoz, et al., 1994; Mora et al., 2020; O'Brien et al., 2020; Carrasco & O'Brien, 2021) observed complex social relationships that requires further analysis which is beyond the scope of this study and should be covered in a future research project.

Surveyed residents knew that their houses required the construction of extensions since there was a gap of approximately three years from initial consultation to the stage when they could begin moving into their houses. Thus, the understanding of the initial satisfaction with the houses and settlement might be influenced by this period as many prepared to build extensions. Additionally, the process of housing modification might also influence the initial residential satisfaction.

The project at Villa Verde

Context

The coastal city of Constitución was one of the most affected Chilean cities following the 2010 earthquake and tsunami, damaging or destroying the homes of 1,260 families in Constitución (Arauco, 2011). The city recovery management included a public-private partnership responsible for delivering the Master Plan for Sustainable Reconstruction of Constitución (Plan de Reconstrucción Sustentable - PRES Constitución - in Spanish) and involved government agencies, the nation's leading timber company Arauco, plus internationally recognized consultants including Elemental and Arup.

In 2009, the year preceding the earthquake and tsunami, the Arauco Forestry company developed a plan to support its workers through private-public funded housing projects within the national housing policy framework. Elemental was commissioned to develop an incremental housing project to suit Arauco's workforce (Aravena & Iacobelli, 2016). Although Villa Verde was not initially designed as a post-disaster incremental housing project, it resettled 244, representing 56% of the total households homeless due to the 2010 disaster.

Arauco and the Chilean government funded the project of Villa Verde through subsidies provided to households under the Housing Solidarity Fund which targets the country's 40% poorest people with the beneficiaries expected to co-fund their housing (MINVU, 2005). To apply for the subsidies, families needed evidence that they have 214,518 CLP (Chilean Pesos), approximately 350 USD (in 2009) in savings¹. In villa Verde, beneficiaries were requested to pay 400,000 CLP, approximately 590 USD, and received the formal ownership of the houses. They were subject to conditions that prevented them from renting the houses out within the following five years and to sell the property in the following ten years from the turnover date.

Design

Villa Verde is located alongside an established middle-income residential area approximately 2.5 km from the city center on land owned by Arauco. The project's economic viability informed the settlement's density, number of houses and ratios between public and private spaces. Villa Verde is dominated by nineteen courtyards each framed on three sides by rows of attached two-story houses with 67% of the houses set within a courtyard. The 484 houses within the settlement come in two types, Types A and B (87% and 13% respectively) (Figure 1). Elemental's designs show that the Type A half-house was built to 57m² and is possibly expanded to 85m². The 62 Type B houses, initially built at 55m², are expandable to 69m². While the Type B houses appear more 'complete' they are limited with only the capacity for expansion at ground level. The 'half house' name is also somewhat misleading in that both halves have been roofed, two-thirds of the electrical work was completed, and the house fully serviced with plumbing and sewerage.

Houses were released to residents in September 2013, accompanied by a 'Habitability Manual' provided by Elemental outlining regulations governing the future development of houses and settlement (Arauco & Fundación Gestión Vivienda, 2013). The manual comprehensively outlined the process for the resident to extend their house in the allocated space and provided the relevant architectural drawings and approval permits. A list of the required materials and construction details produced to streamline the process came with a warning that unspecified additions would require additional permits, and formal approval from the residents in Villa Verde organized through the neighborhood associations (Arauco & Fundación Gestión Vivienda, 2013). Importantly, the manual did not specify budgets, timelines, or stages for the construction of housing extensions.

¹ The Housing Solidarity Fund requires 10 UF Unidad de Fomento as beneficiaries' contrbition. UF is a unit of account used in Chile which is regularly adjusted for inflation. In January 2009, 1UF=21,451.8 CLP

Beneficiaries' selection and housing allocation

Before the 2010 disaster, the intended beneficiaries of the houses at Villa Verde were Arauco workers; however, the aftermath of the disaster eligibility was extended to include 244 households recovering from the disaster alongside 240 Arauco workers. In many cases, households qualified on both grounds.

Houses were allocated with a semi-formal system with many households provided an opportunity to show preference for their type of house and its location. Households that had contributed during community meetings and workshops with Elemental and Arauco were given preference alongside the leaders of the neighbors' organizing committees and the families that collaborated in the consultation process. Beneficiaries unable to participate in the pre-occupancy events were assigned housing units that might not accommodate their preferences, especially as some houses lacked car parking spaces and others were smaller.

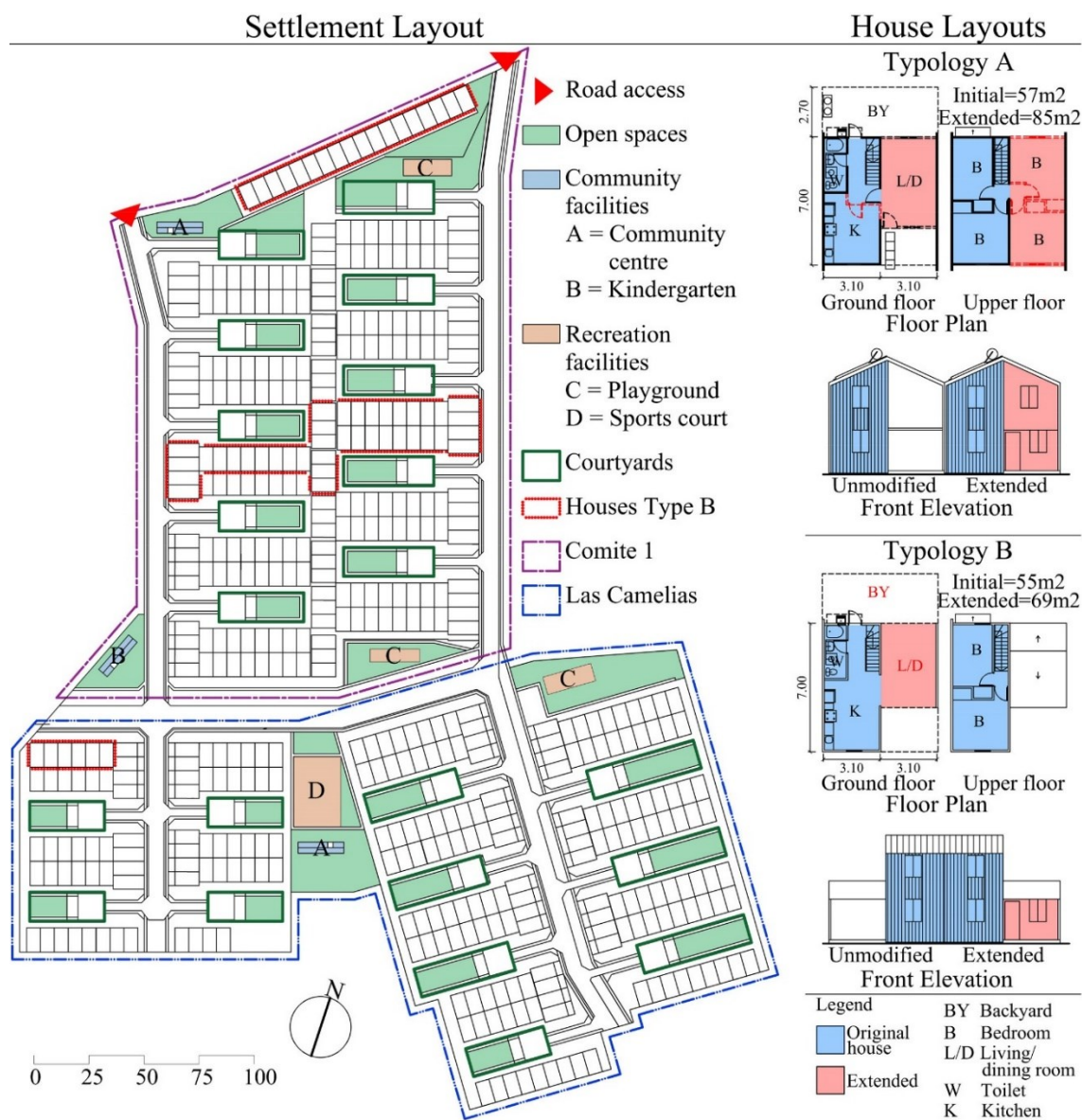


Figure 1 – Settlement layout of Villa Verde, housing design and extended houses. Source: Authors (2021).

Households' characteristics

The general characteristics of the interviewed households are summarized in Table 1. Households are mostly middle size with 4-6 members, followed by smaller families, mainly nuclear and childless families. Although, there are extended families with up to 8 members. In the 40 households surveyed, 167 people aged from 3 to over 60 years old, the largest group are adults between 20 to 60 years old. Male family members are financially responsible for almost half of the surveyed households. However, in 38% of the families, both male and female members share financial responsibilities. Most of the households reported that they have a regular income. It was observed that the residents are a heterogeneous group with families earning less than the minimum wage to three times the minimum wage. Most of the working family members are dependent workers, and four reported that they work for Arauco, the promoter of Villa Verde.

Table 1 – Households' characteristics

Households' key characteristics		% (No)
Household characteristics	Family size	
	1 to 3	38% (15)
	4 to 6	48% (19)
	7 to 8	15% (6)
Household type	Nuclear family	43% (17)
	Single parent family	5% (2)
	Extended family	30% (12)
	Childless family	5% (2)
	Retired/senior couple	10% (4)
	Other	8% (3)
Age	Under 3 years old	3% (5)
	3 – 10 years old	15% (25)
	10-20 years old	20% (34)
	21-39 years old	26% (44)
	40-60 years old	23% (39)
	Over 60 years old	12% (20)
Economic parameters		
Financial responsibility	Male	48% (19)
	Female	8% (3)
	Both	38% (15)
	None	8% (3)
Income	Regular	80% (32)
	Irregular	20% (8)
Monthly family income	Less than one minimum wage*	10% (4)
	1 to 1.5 minimum wage*	50% (20)
	1.5 to 2 minimum wage*	15% (6)
	2 to 2.5 minimum wage*	13% (5)
	2.5 to 3 minimum wage*	13% (5)
Employment	At least one person employed	53% (21)
	More than one employed	40% (16)
	Retired/receive gov. subsidy	8% (3)
	Unemployed	-
Type of job	Dependent worker	71% (39)
	Independent	29% (16)

* Minimum wage in Chile 270,000 Chilean Pesos = Approximately USD 405 (on 20/07/2017)

Source: Authors (2021).

Housing conditions prior to Villa Verde's occupation

Analyzing Villa Verde's residents' pre and post housing conditions is crucial to understanding their level of satisfaction with their current homes. Research by Snarr and Brown (1980) has demonstrated the importance of analyzing resident's attitudes including changes in housing location, disruption to social structures, and the need to restore fractured relationships to physical and social environments. These challenges are complex at Villa Verde as the process was voluntary for many of the Arauco's workers and potentially involuntary for the disaster-affected households.

Barenstein (2012) highlights factors that play a significant role in the residents' capacities to identify with their new housing and cites factors such as distance from the place of origin, access to basic services, accessibility, livelihood opportunities and access to common facilities. At Villa Verde, most families (63%) had previously lived within the Constitución's urban area, 20% in peri-urban areas, 5% in rural areas close to Constitución, and 12% from the town of Santa Olga approximately 22km from Constitución.

Analysis of the ownership status of the former houses reveals that prior to forming households at Villa Verde, 68% of residents were non-homeowners with 45% sharing with relatives and 23% as tenants. 30% of Villa Verde's households had previously owned their houses. Directly resulting from the 2010 disaster, 60% of the surveyed households lost their homes or were relocated, while 40% reported little or no damage, with the disaster having no bearing on their decision to relocate to Villa Verde. The survey revealed that almost 68% of the residents changed their livelihood in the four years after Villa Verde's occupation and that 58% were located the same distance or closer to their workplace.

Residential Satisfaction

Housing selection and initial occupancy

Regarding the reasons behind residents' preference to move into Villa Verde, 58% (23 out of 40) mentioned that this was the only housing project available for them at the moment. Although, following the disaster, other options such as units in apartment buildings were also available for disaster-affected families. Another critical factor for residents was the flexibility to extend the houses. Reasons related to access to livelihood, proximity to relatives or friends, and preference for the housing layout remain low. However, two households pointed out that they preferred a house rather than an apartment.

The completed houses were released to residents in late September 2013. Half (53%) occupied their new homes immediately with others moving in the following months. Delays in the occupancy were linked to resident's concerns about extending their houses while addressing other family issues to resolve. Only one household admitted a lack of motivation to begin extensions.

Housing satisfaction levels four years after occupation

Understanding the residents' perspectives about their homes at both initial and post-occupancy stages can underscore the successes and problems within a resettlement project not anticipated before daily routines and activities in the new houses are resolved (Oliver-Smith, 1991). Additionally, the changes in housing satisfaction act as a predictor of residents' attitudes toward housing adaptations (Manalang et al., 2003; Carrasco et al., 2017).

For the analysis of residential satisfaction, ten indicators were considered, and residents choose among them on a five-point scale of satisfaction: 1) Location of the settlement; 2) Tenure conditions; 3) Size of the plot; 4) Size of the house; 5) Strength of the house; 6) Quality of construction; 7) Thermal comfort; 8) Acoustic comfort; 9) Aspirations fulfilled; and 10) Safety in the settlement. The definition of the indicators for satisfaction evaluation was based on understanding the physical environment,

residents' socioeconomic situation (Lizarralde & Bouraoui, 2010; Barenstein, 2012; Perera et al., 2012), and experiences (Francescato et al., 1989) inherent to their daily routines (Ahrentzen, 1992) and living conditions (Carrasco et al., 2016). The analysis of the satisfaction indicators considered the comparison of residents' impressions about their pre-resettlement and current housing conditions and environment after four years living in the houses and having performed multiple housing adaptations.

The data obtained from resident questionnaire survey was processed according to equation (1) to obtain the satisfaction scores 'x' per indicator: $R = \text{Total number of respondents}$.

$$x = \frac{R_1(i) + R_2(i) + R_3(i) + R_4(i) + R_5(i)}{R} \quad (1)$$

R1= Highly satisfied

R2= Satisfied

R3= Neutral

R4= Dissatisfied

R5= Highly dissatisfied

For the analysis or comparison of the initial and post-occupancy satisfaction per indicator, the answers obtained were assigned a scoring index 'i', detailed as follows:

Highly satisfied=+2, satisfied=+1, neutral=0, dissatisfied=-1, highly dissatisfied=-2

Broadly speaking the residents' satisfaction has risen during their four years occupying the houses at Villa Verde with Figure 2 recording variation in residents' satisfaction levels. Overall, it reflects a positive attitude towards the houses – both in the initial stage and four years of inhabitation and demonstrates increased levels of satisfaction coinciding with the extensions or internal modification process. The most significant improvements to the residents' satisfaction levels were attributed to factors such as the increased size of the house, improved qualities within the house. Although not all the residents had a positive perception of the 'half-finished house' design *"At the beginning we used to call these houses "matchboxes" because they seem tiny, but later we realized that once extended, they can be big"* (Female, 30).

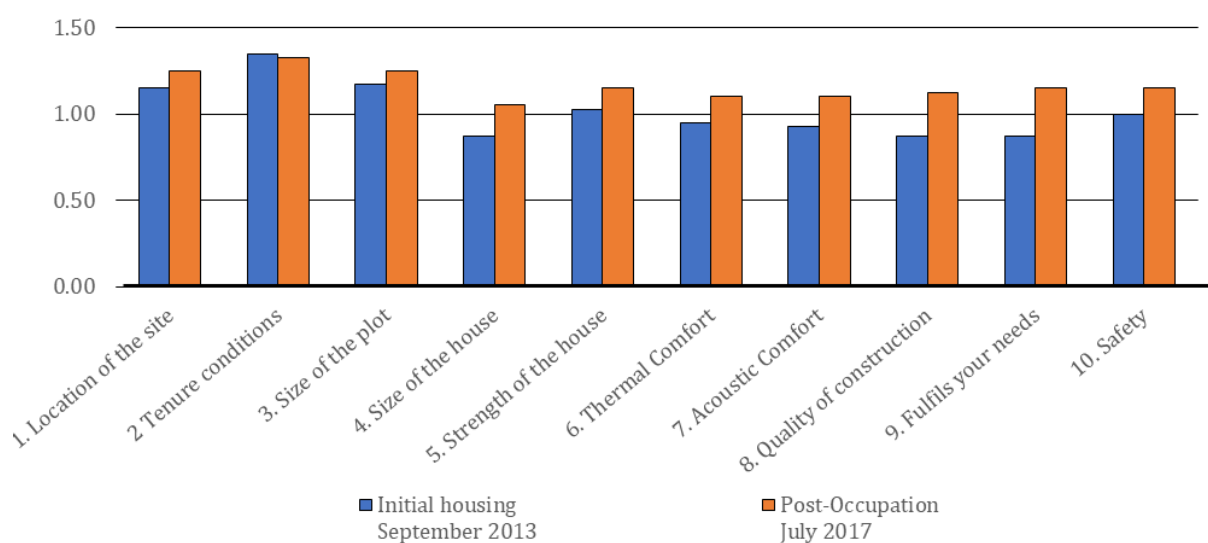


Figure 2 – Comparison of residents' satisfaction levels, 2013 and 2017. Source: Authors (2021).

The construction of housing extensions has become one of the factors that highly impact the residential satisfaction and created a sense of pride *"I like how much we changed in the house since we received it. All with our own effort and little by little with my neighbors help"* (Female 33). However, the need to build also created stress in the residents that are unable to build extensions quickly *"The only thing I don't like about my house is that I still can't build extensions because it is costly"* (Male, 47).

Residents' satisfaction with the settlement's location also increased as the frequency of regular public transportation improved. However, the distance from the city center is still a concern for them *"I don't like the location of the settlement that is far from the city especially when we go for shopping"* (Female 31). Many residents also had the possibility to choose the location and the typology of their house (type A and type B presented above). Among the 32 interviewed residents, 13 choose the location of their house *"We wanted the house next to the main street and in a corner to extend to the side. We actively participated in the coordination meetings, so we had the right to choose our preferred house"* (Female, 52). The houses' location also impacted how the residents extended their houses *"I am happy that my house is on the main road because I just opened a shop"* (Female, 27).

There was no discernible change to the high levels of satisfaction regarding tenure conditions. For 14 of the interviewed residents expressed that what they like most about the houses is that they have formal ownership, although they also mentioned that the restrictions to transfer or sell the house need to be lifted.

Residents are mostly satisfied with the plot size, however other needs such as parking was a concern *"I would prefer a bigger plot so we could park inside our plot and not in the street or the courtyard"* (Male, 36). The residents have a good perception of the strength of the house and the construction materials. Factors such as thermal comfort and acoustic performance of the houses, initially high, increased particularly after the installation of wood heaters.

Patterns of housing adaptations

This section analyses the quantitative information collected from 40 households to reveal examples of the types of modifications that took place and provide some understanding of the factors driving the process. Elemental had anticipated specific extensions, *formal adaptations*, and produced a 'Habitability Manual' to assist the residents in making these additions. This document outlined the rules for joint property ownership Villa Verde is a residential condominium. Importantly it also included technical instructions to enclose the incomplete 'half house' and how to maintain it but did not specified timelines or budgets (Arauco & Fundación Gestión Vivienda, 2013). Figure 1 indicates the areas had been specified for housing extensions, including additional bedrooms and living areas. These additions had also been formalized by relevant government agencies.

For the purposes of this paper, we have identified *informal adaptations* which includes additions not anticipated or recorded on the architectural drawings or described in the 'Habitability Manual'. This includes extensions to the front and rear of the houses. Housing adaptations are also differentiated regarding the addition of covered space called *extensions*, while *modifications* are referred to renovations or improvements within the existing spaces.

Table 2 - Patterns of housing adaptation

Spaces built				Location		Changes in the original use
Type of adaptation (No)	Formal	Informal	Combined	Planned framework (No)	Story (No)	
Living room (32)	15†	-	17†	Within framework (32)	Ground floor (31) Upper floor (1)	None (121)
Dining room (35)	16†	-	17†	Within framework (35)	Ground floor (34) Upper floor (1)	
Kitchen (12)	-	1*	4†	Within framework (10)	Ground floor (11)	
Bedroom (55)	-	-	7*	Rear/backyard (2)	Upper floor (1)	Partly (18)
	23†	2†	28†	Within framework (54)	Ground floor (6)	
	-	-	2*	Rear/backyard (1)	Upper floor (49)	
Shop/workshop (4)	-	1†	2†	Within framework (3)	Ground floor (4)	Completely (25)
	-	-	1*	Rear/backyard (1)	Ground floor (4)	
Storage (5)	2†	-	3†	Within framework (1)	Ground floor (4) Upper floor (1)	
Covered parking (4)	-	4†	-	Rear/backyard (4)	Upper floor (1)	Completely (25)
	-	-	-	Front garden (3)	Ground floor (4)	
Covered backyard (11)	-	11†	-	Rear/backyard (1)	Ground floor (11)	

† = Extensions

* = Modifications

Source: Authors (2021).

The survey (Table 2) revealed that 35 of the households built their houses, 17 strictly followed the guidelines for extensions while 17 households constructed both formal and informal adaptations. One house completed an informal extension only. Table 2 also shows that most of the adaptations were performed by households who combined formal and informal adaptations. Households performed a total of 316 adaptations, from them only 12 were renovations or *modifications*. Most of the formal extensions were bedrooms, living and dining rooms (Figure 3, house 1) while most of the informal extensions were built in covered backyards. It was common for residents to enclose a kitchen in the backyard while others covered the backyard against rain and dust using this space for laundry, storage of firewood and tools as it is shown in Figure 3. Housing adaptations were mostly built within the designed framework (16) and the rear of the house (16), while only 3 built in the frontal garden. Informal extensions to the front of the houses have been used for various purposes, including small businesses (Figure 3, house 3) or covered carports. Enclosures in the front yard is also a common practice as 53% of all the residents in Villa Verde have occupied this space (O'Brien et al., 2020) although these are not covered spaces. Most of the housing adaptations were built on the ground floor and in the houses upper floors are mostly used as bedrooms. Regarding the change of use of the original house design, most of the spaces built keep the original use, although residents partly or completely changed the use of 43 spaces.

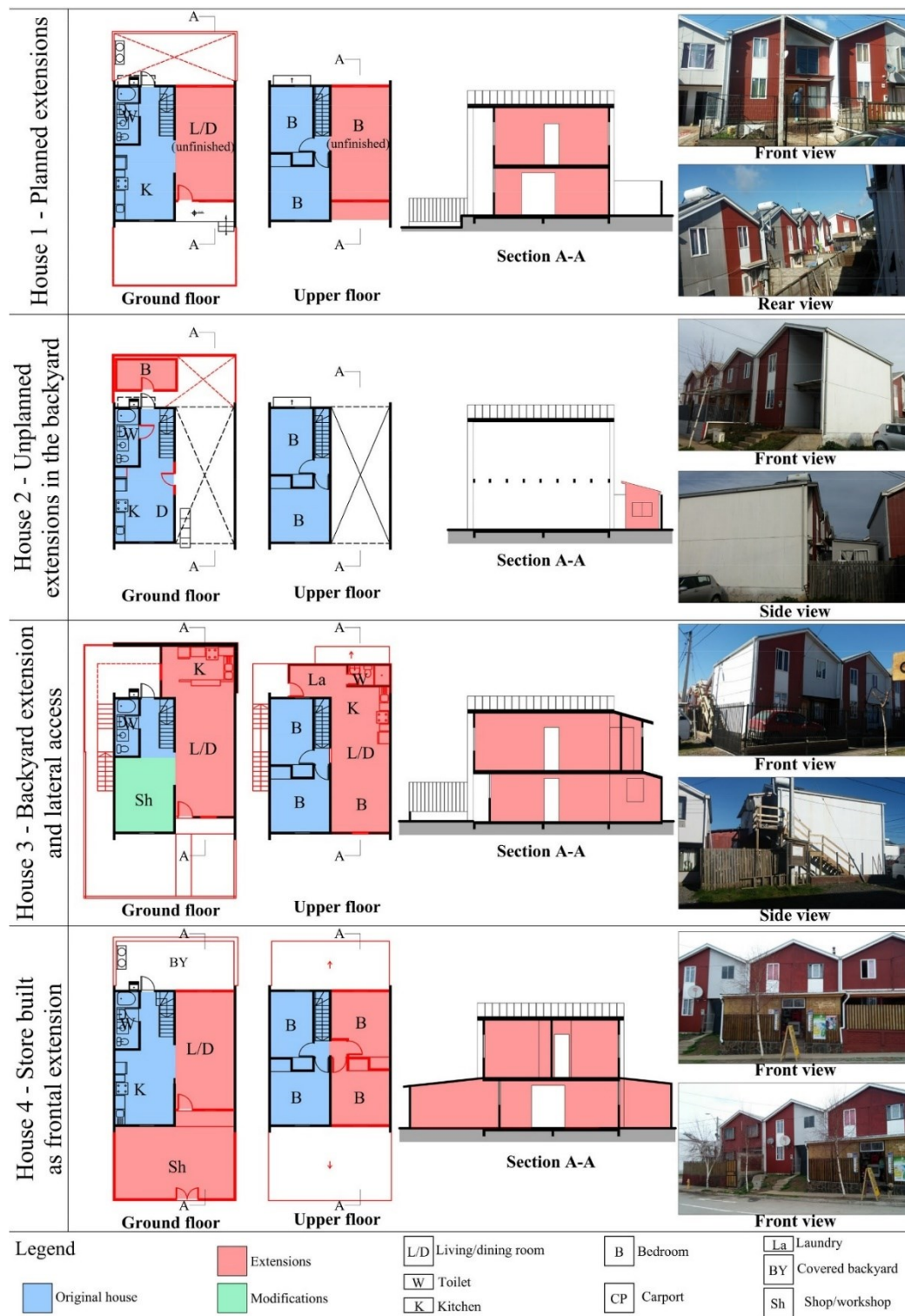


Figure 3 – Adaptations built by residents. Source: Authors (2021).

Construction began at Villa Verde in January 2012 and residents began financial preparations to build their houses leading to many houses being modified soon after residents gained tenure. Within the first three months, 60% of the surveyed residents had occupied their houses with 23% starting modifications immediately. By the end of the second year 98% of the houses were occupied with 53% of residents modifying their houses. By the third year only one new household was added, and five new households began modifying. At the end of four years the last resident moved in to avoid forfeiting ownership rights and all the sample houses had been modified to varying degrees.

Figure 4 highlights that the highest activity was undertaken in 2014, between three to fifteen months after the residents moved in the houses. The priority was the construction of living and dining rooms followed by bedrooms – all part of the formal plans. Kitchen and toilet improvements were not highly rated early in the modification process but by 2017 have become the highest priority. The opportunity to enclose the rear yard was most popular in the middle phase of development. Additionally, shops or workshops (i.e., grocery stores, food stalls and sewing workshops) started to appear as spaces to support the family income, within the surveyed households, three built informal extensions and one modified the living room to accommodate a small shop. These findings echo Sepúlveda, Muñoz, et al. (1994) observations about the non-linear nature of the process of incremental housing construction which usually have an initial momentum that decreases as the housing needs are covered.

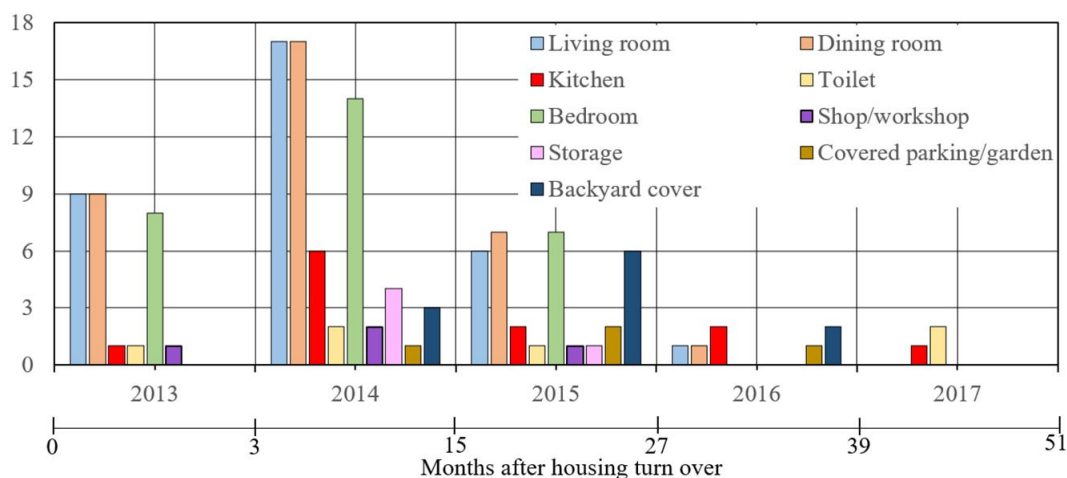


Figure 4 – Progress and type of housing adaptations. Source: Authors (2021).

Interviews have provided evidence that the 'Habitability Manual' assisted many households realize their improvements to the houses. Figure 5 reveals that twice the number of residents completed the construction process themselves rather than hiring a professional contractor to complete the works. There was a third smaller contingent who were supported in their efforts by neighbors and friends. Remarkably some internal improvements of the spaces were the result of government-provided subsidies, under the Family Property Protection Program, obtained after group applications to housing improvement schemes such as the senior neighbors committee. At the time of the survey, six households were granted these subsidies while seven applied and were waiting for the results. In these cases, the related government agency was responsible for managing the construction and providing qualified skilled workers. Although residents were grateful, they complained about not being able to manage the budgets directly.

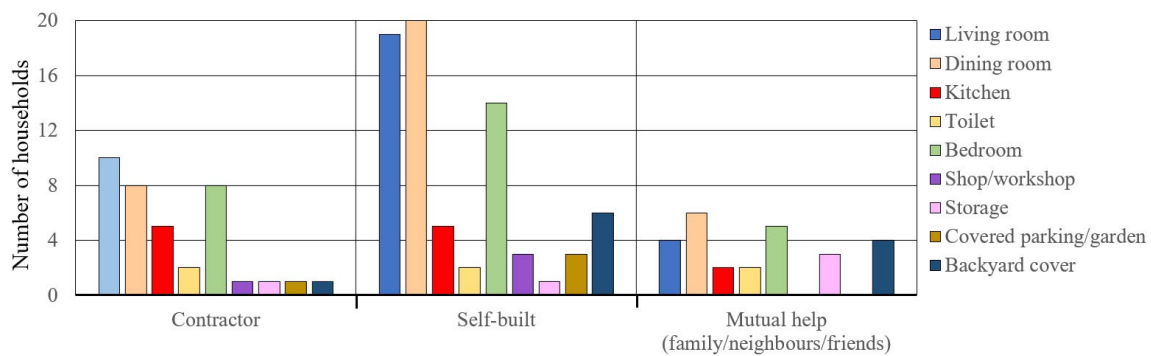


Figure 5 – Builders of housing adaptations. Source: Authors (2021).

The process of housing adaptations is likely to continue in the future as 55% of the residents expressed a desire to continue improving their homes. Only 20% believed they already achieved their desired home.

Reasons for housing adaptation

Households were asked to share the decisions behind their choices to improve their houses, increase floor area and improve the quality and finishes of their living spaces (Figure 4) synthesizes these priorities by mapping the progress of the extensions alongside the spaces modified. The residents' first priority was to improve the spaces where social interaction takes place, such as living and dining rooms, to improve quality and comfort (Table 3). Service areas such as kitchen and toilets were also modified, rather than extended, to improve finishes and workability.

Older people, particularly those with reduced mobility, were concerned by the location of bedrooms on the upper floor. Many responded by reconfigured their houses and locating bedrooms downstairs. In addition, many replaced the bathtub, which was considered dangerous, with a shower while others modified the space for additional storage or installed a washing machine.

Eleven households used the house for commercial activities and modified interior spaces accordingly. These modifications range from the enlargement of the cooking area and increased storage through adding serving counters, shopfronts. and consulting rooms.

Issues of security and ownership drove many of the extensions to the surveyed houses. Front fences were constructed to demarcate the residents' property and provide some sense of security from intruders. Carports protect cars from inclement weather and highlighted the household's car ownership. Issues of security were often taken to a higher level in the rear yard with enclosures providing storage and laundry spaces protected from rain, dust and cold weather. The settlement's relatively high density caused many households' privacy issues which were addressed by enclosing the rear yard to various extents.

Table 3 - Reasons for housing adaptation

Adaptation		No. of households who built*	More space(s)	Comfortable spaces	Reason for adaptation †			Not sure/no answer
					Privacy	To work/livelihood	Security	
Social spaces	Living room	33	20 (61%)	21 (64%)	1 (3%)	-	-	2 (6%)
	Dining room	35	18 (51%)	20 (57%)	-	-	-	4 (11%)
Service areas	Kitchen	12	4 (33%)	9 (75%)	-	1 (8%)	-	-
	Toilet	5	4 (80%)	5 (100%)	-	-	-	-
	Storage	4	3 (75%)	-	-	1 (25%)	-	-
Resting spaces	Bedroom	31	24 (77%)	20 (65%)	-	-	-	3 (10%)
Livelihood	Shop/workshop	4	-	-	-	4 (100%)	-	-
Carport/covered front garden		4	1 (25%)	-	-	-	3 (75%)	-
Covered backyard		11	1 (9%)	3 (27%)	2 (18%)	1 (9%)	8 (73%)	-

Notes: * = Either extended or renovated

† = Could be combined with other reasons

Discussion: Learning from Villa Verde

Villa Verde captured the most interest, particularly in the media, for its striking architectural response. However, four years later, it is vital to question if the development lived up to its expectations and identify lessons to be drawn from this project. This paper has provided multiple layers on which to view the project favorably with two broad measures highlighted.

Firstly, close to all the houses in the settlement have been extended to complete their missing 'half'. This represents a significant investment on behalf of the residents and reveals their endorsement of the incremental process as it operates at Villa Verde. Although the 'Habitability Manual' attempted to provide a framework for formal outcomes, significant evidence shows that the resident-controlled extensions have exceeded the formal process detailed in the manual via an informal process with significant ramifications for the settlement's liveability and functionality.

Secondly, this study revealed the many categories where the resident's satisfaction levels have improved in the four years after occupation. The most significant rise relates to the capacity of residents to improve their houses with the surveys revealing the residents' endorsement of the strategy to place responsibility in their own hands to self-manage improvements according to financial capacities and individual aspirations. Consciously or not, this has encouraged the spate of additional informal structures beyond those formally identified by Elemental. Furthermore, variety and extent of informal additions, demonstrates that incremental process is likely to continue and take on more complex forms. Some households also raised questions around whether the site planning might have been reconfigured to provide a more equitable urban design solution.

The housing evolution in Villa Verde provides evidence the residents' capacities to improve their living conditions. Residents are aware that the extensions they built beyond the manual require further formalization processes. However, this process results complex and limit the residents' access to further housing improvement subsidies. Nevertheless, in case of Villa Verde the local government in Constitución started negotiations with the residents to formalize the extensions, in August 2019, six years since they moved in the houses, however, still there are no concrete actions taken.

Settlement management and inclusive governance remains a challenge beyond the globally recognized housing designs which balance individual and collective incremental development. Long-term outcomes from sites and services projects (Sepúlveda, Muñoz, et al., 1994) and studies about the first Elemental's housing project 'Quinta Monroy' (Millones S., 2017; Carrasco & O'Brien, 2021) evidenced

the loss in community communication and limited collective capacities in contrast to individual housing improvements.

Conclusion

Elemental has developed a global reputation with the 'half-house' system that overlays a self-build framework over an industrialized framework – informal overlaying the formal. Once the residents received their houses, the settlement's changing fortunes were in the hand of the residents – well almost. The Habitability Manual was supposed to guide the housing additions that were endorsed and formal in nature. As discussed, this outlined standard procedures to follow with no alternate variations offered. As we have seen the range of additions has been significant with higher densities of housing extensions within the rear yards. Thus, the spontaneous housing development might compromise the housing and neighborhood quality in the mid and long term.

Supporting mechanisms to finance incremental housing remain an issue that should be studied, focusing on understanding the relationships between housing investment and households' socio-economic conditions. Moreover, the existing government funding schemes should integrate partnerships among financial institutions, materials suppliers, developers at various scales – including microcredits.

Finally, the future of incremental housing projects is of great interest globally and should be analyzed in the middle and long-term. Hopefully, the designers should consider the feedback from the residents who beyond the prizes and the publicity are the ones who experience how is to live in Elemental's designed houses.

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Data Availability Statement

The data that supports the findings of this article is openly available in SciELO DATA and can be accessed at <https://doi.org/10.48331/scielodata.J6KE9P>

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