Assessing Sustainable Urban form in Social Housing Neighbourhoods: Two cases in Southern Chile

Evaluación de la sostenibilidad de forma urbana en conjuntos de Vivienda social: dos casos en el sur de Chile

Mehmooda Maqsood
ORCID: https://orcid.org/0000-0002-5692-3141
Karachi, Pakistan.
Correo electrónico: momookhan@gmail.com

Antonio Zumelzu
ORCID: https://orcid.org/0000-0003-0257-1766
Universidad Austral de Chile, Valdivia, Chile.

Abstract

For a few decades, understanding land-use with integrated services and socially mixed groups has been considered vital to endure nature and societies in harmony. This article promotes inclusivity in planning neighbourhoods, by encouraging principles of urban form, towards a sustainable quality of life. In Chile, with the creation of SERVIU, homelessness was resolved by a quantitative approach of housing programs, promoting an exclusive urban expansion process, generating social segregation, and an over-concentration of precarious living conditions. Contrarily, in 1960 the focus of planning was oriented towards planning sustainable neighbourhoods under CORVI Programs, recognizing fundamental morphological principles. The aim of this article is to explore the spatial conditions and quality of life in neighbourhoods under SERVIU and CORVI programs, by evaluating elements of urban form. Elements to explore are: accessibility to services, commerce and recreation; vitality of social and commercial nodes; and diversity in land use and housing typology. Analising cases of Reina Sofia in the city of Valdivia and Rahue Bajo 2 in the city of Osorno, assessed through methods of People Following (Talen, 2011), Gates and Snapshot (Vaughan, 2001) and Simpsons Diversity Index - results show that CORVI programs include sustainable morphology in its urban form, which improves quality of life, in contrary to SERVIU Programs.

Keywords

CORVI; local planning; neighbourhood quality of life; sustainable social housing; urban form

Resumen

Desde hace algunas décadas, la comprensión del uso de la tierra con servicios integrados y grupos socialmente mixtos se considera vital para soportar la naturaleza y las sociedades en armonía. Este artículo promueve la inclusión en la planificación de barrios, fomentando principios de forma urbana, hacia una calidad de vida sostenible. En Chile, con la creación del SERVIU, el sinhogarismo se resolvió mediante un abordaje cuantitativo de los programas de vivienda, promoviendo un proceso de expansión urbana rápida y exclusiva, generando segregación social y una sobre concentración de condiciones de vida precarias. Por el contrario, en 1960 el enfoque de la planificación se orientó hacia la planificación de barrios sostenibles bajo los programas CORVI, reconociendo principios morfológicos fundamentales. El objetivo de este artículo es explorar las condiciones espaciales y la calidad de vida en los barrios de los programas SERVIU y CORVI, mediante la evaluación de elementos de forma urbana. Los elementos por explorar son: accesibilidad a los servicios, comercio y recreación; vitalidad de los nodos sociales y comerciales; y diversidad en el uso del suelo y tipología de vivienda. Analizando casos de Reina Sofía Valdivia y Rahue Bajo 2 Osorno, evaluados a través de métodos de People Following (Talen, 2011), Gates and Snapshot (Vaughan, 2001) y Simpsons Diversity Index. Los resultados muestran que los programas CORVI incluyen morfología sostenible en su forma urbana, que inciden positivamente en la calidad de vida, a diferencia de los programas SERVIU.

Palabras clave

Calidad de vida del barrio; CORVI; forma urbana; planificación local; vivienda social sostenible

HISTORIAL DEL ARTÍCULO

Recibido:
12 de diciembre de 2019.
Aceptado:
03 de mayo de 2021.

CÓMO CITAR ESTE ARTÍCULO:
Cómo citar: Maqsood, M., & Zumelzu, A. (2021). Assessing sustainable urban form in Social Housing Neighbourhoods: Two cases in Southern Chile. *Revista de Urbanismo*, (44), 149-165. **https://doi.org/10.5354/0717-5051.2021.54756**

Introduction

Housing is not only the unit that shelters people, but an integrated system of the social and spatial domain. It can be understood as the interlinkage between land, infrastructure, and services-overlapped by the arrangement of subsistence, protection, freedom, and transcendence for its residents within a context (Holm, Murray & Pauw, 2005). In Chile, the different housing policies for different income groups resulted in a range of neighbourhoods that play a vital role in shaping the morphological growth of mid-sized Chilean cities. In the past 30 years, after the change of economic model to neoliberalism, and since the creation of the planning body SERVIU (*Servicio de Vivienda y Urbanismo*–Housing and Urbanization Service), housing policies have resulted to resolve the deficit of housing at the periphery of the city. This quantitative approach resolved a large amount of housing deficit through market-oriented development, promoting a rapid and un-inclusive urban expansion process, without consideration to sustainable urban form. This approach has been causing critical problems to residents' quality of life (Jirón & Cortés, 2004). Chilean housing policies expose issues of location, allocative efficiency, segregation, design, and construction inadequacies, among others. It can be understood as a *Paradoxical Happiness* where residents, on the one hand, have housing but, on the other, the integration of services, public amenities and a socially cohesive neighbourhood is not provided (Cáceres Seguel, 2015).

On the contrary, housing projects in the 1960's, developed by the Planning body CORVI (*Corporación de la Vivienda*–Housing Corporation), the predecessor of SERVIU, generated a new way to create neighbourhoods, using planning criteria that recognized the individual, family and community life as fundamental principles for urban development (Demiddel y Pérez-Bustamante, 2009; Zumelzu, Gruehn & Hosni, 2019). These neighbourhoods incorporated inclusive, sustainable conditions in its urban form such as connected mobility within the neighbourhood and to the city, contained building forms with mixed housing typologies, opportunity for small scale commerce, and well-designed public spaces for diverse uses. In short, CORVI had qualities that run counter to the current mode of neighbourhood planning which promotes segregated land use, socially insular and physically disconnected housing, and lack of spaces for small business, recreational and social activities.

The aim of this research is to study planning principles of the sustainable urban form of social housing neighbourhoods, by a comparative analysis of two case studies from SERVIU and CORVI programmes, to evaluate and propose recommendations for spatial planning guidelines at the local level.

The hypothesis states that Social Housing Neighbourhoods planned by CORVI comprise of planning principles in its built environment, as fundamental tools of neighbourhood. The methodology evaluates three dimensions of sustainable urban form which is broadly discussed in the literature: accessibility, neighbourhood vitality, and diversity. Results are concluded in the form of recommended planning instruments and policy guidelines, which are proposed for future challenges to orient social housing neighbourhoods towards a more sustainable course.

Neighbourhood Sustainability as a Practical Guide: The Experience of Social Housing Programs of CORVI

The term 'Neighbourhood Quality of Life' is not used to only describe physical features, but also to describe the non-physical dynamics, and the reticular relationships that exist between those physical features (Talmage, Hagen, Pijawka, & Nassar, 2018). Thus, the definition of a sustainable quality of life in neighbourhoods lies in the network and complexity rather than in the linear and elementary. As sustainability becomes an increasingly important element to be considered in planning urban areas, it is central in the consideration of cities, and even more in the development of neighbourhoods. Cities cannot be thought of as sustainable, if their component parts, such as neighbourhoods do not meet the sustainability criteria (Green, Grimsley & Stafford, 2005).

Lack of planning principles in Chile has opened the way to sprawl, indicating that Chilean cities are following a pattern of change similar to that observed in the 1950s in the context of the United States (Salinas Varela & Pérez Bustamante, 2011). Urban sprawl can be defined as development that is low density, car-dependent, and homogeneous, having adverse effects on environmental quality, social cohesion, and human health. Studies suggest that these developments are resulting in a process of fragmentation and privatization of the space, increasing segregation and social polarization (Inzulza-Contardo & Gatica-Araya, 2018). Segregation through housing also highlights the role of neighbourhoods in shaping outcomes, such as education and delinquency, as well as other intangibles such as deprecated identity, self-esteem, lack of a sense of belonging and placelessness (Billig, 2005). In this way, local units such as the neighbourhood, which forms to be the microstructure of cities, where the community articulates the private space of the private with the public, gradually loses its structure, identity, and vitality (Borsdorf & Hidalgo, 2013; Zumelzu-Scheel, 2016).

In 1953, during the government of Carlos Ibáñez, CORVI Housing Corporation was created as a planning institution. It came about as the result of the merger of two pre-existing entities: The Housing Fund and the Reconstruction, and Assistance Corporation. One of CORVI's main objectives was to promote housing research and housing policy, along with promoting the construction of affordable housing, as well as the execution, urbanization, restructuring, remodelling and reconstruction of neighbourhoods (Raposo, 1999). One of the main characteristics of the CORVI was that many of its planning sets were created within the framework of the *Neighbourhood Unit*, a concept proposed by Clarence Perry in 1928, which promoted design patterns inherited from modern urbanism in the United States (Tapia, 2005; Lloyd Lawhon, 2009). In 1947, the concept was formally introduced in Latin America during the sixth Pan-American Congress of Architects (Demiddel & Pérez-Bustamente, 2009).

The urban principles of CORVI are summarized in the physical organization of social functions such as: primary schools, green areas, provision of goods and services, open spaces and community centres, all at distances of 400 to 800 meters within a neighbourhood. Another distinguishing feature of the CORVI is the presence of certain building characteristics, consisting of collective or paired housing blocks, and other morphological aspects of the housing complex. The diverse forms of land grouping, the organization and hierarchy of public spaces, the definition of basic functions, and the disposition of the building bodies represent characteristics that reiterate patterns, and project practices attributable to the doctrinal unity of the *School of CORVI* (Raposo, 1999).

Nowadays, neighbourhood planning of social housing in Chile lacks the perceived quality of life and is dispiriting residents from experiencing and transforming space according to community cohesion, accessibility, diversity, and neighbourhood vitality.

The need for Sustainable Planning Principles in Social Housing Neighbourhoods

Green et al. (2005) discuss that well-being is a holistic concept of human health, and it is inextricably linked to the environment we dwell in. Built landscapes that do not serve real human needs can be extremely detrimental to the growth of the community (Green et al., 2005). Whether the causes are economic forces, consumer preferences, or misguided public policies, the dominant form of urban development in the Chilean neoliberal economy can be characterized as urban sprawl (Guzmán-Concha, 2017). This can be mitigated by policies that promote contained urban growth, mixed land uses and cultural backgrounds, pedestrian-friendly environments, public transit, urban revitalization, and native land preservation. Sustainable urban form encapsulates a range of morphological principles in neighbourhood planning, and studies show that accessibility, neighbourhood vitality and diversity are necessary to incorporate when planning neighbourhoods towards sustainable sociability. Scientific evidence demonstrates that these dimensions

are most demanded to influence sustainability and human behavior in the city.

Accessibility in Urban Form

Accessibility is a particularly important aspect of neighbourhood sustainability (Jacobs, 1989; Lynch, 1981). Increasing access to needed facilities and services among low-income populations should be included as an essential part of social policy. Access to resources defines the '*Geography of Opportunity*', where proximity to resources significantly impacts the ability of low-income residents to have spatial equity (Briggs, 2005). In this regard, accessibility is not conceptualized as an issue of private mobility but is generally approached as a community-wide, public problem (Talen & Koschinsky, 2011). Equity in accessibility to resources is therefore tied to the principles of smart growth (Song & Knaap, 2004) and active living environments, in which pedestrian access to daily life needs is viewed as especially important.

In mid-sized Chilean cities, the principle of accessibility is important, as cities are expanding through the housing industry in the form of sprawl. Sprawl is essentially resulting in homogenous land use, which means that houses are provided to citizens as cities expand, but access to services is still concentrated in and around the centre. This automatically supports car-dependency, and the low-income residents end up with unsustainable patterns of spending, mobility, and overall lifestyles.

Vitality in Urban Form

Neighbourhood Vitality refers to the degree to which local environments offer points of connection and contact, to people and resources at a variety of scales, and for multiple purposes. Higher vitality leads to higher levels of interaction between residents and environment, society, and cultural & economic activity; all of which improves the ability of a place to sustain itself in the long term. Interaction at the neighbourhood scale is often a pedestrian phenomenon (Michelson, 1977), and networks of neighbourly relations are related to interconnected pedestrian streets and integral nodes. From this point of view, increased nodality in urban form renders to small blocks and streets that connect, establishing common crossing points where multiple activities can blend, with well-located facilities that may function as shared spaces.

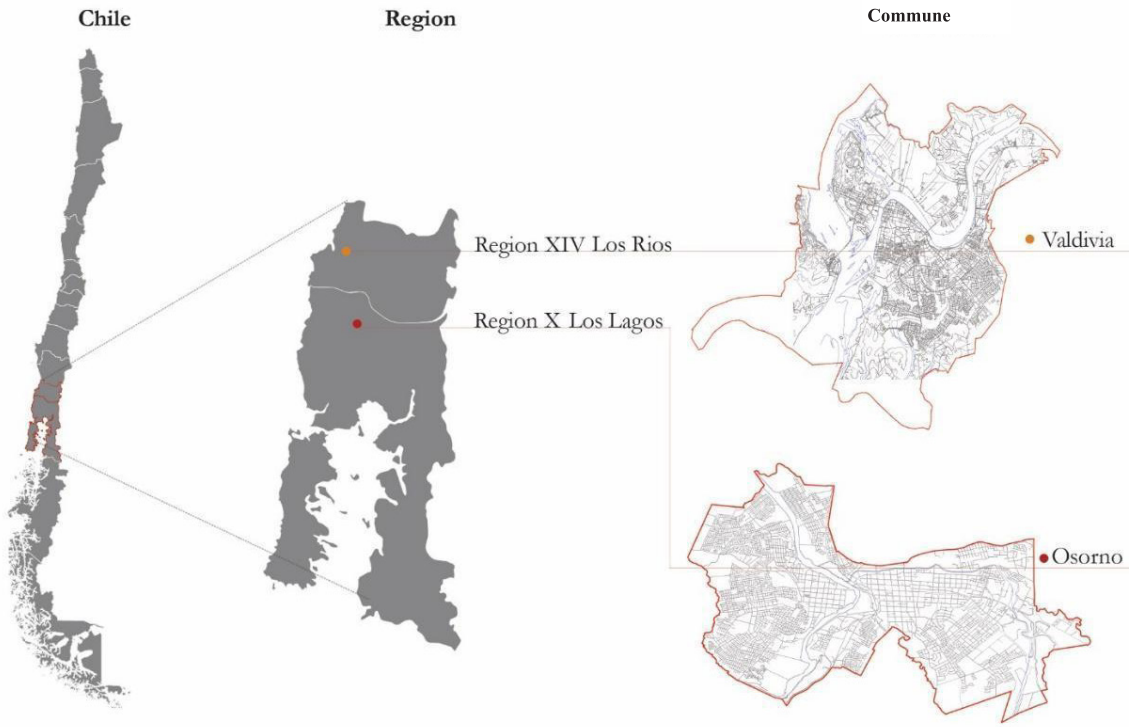
Vitality in the Chilean context is particularly important, as middle-income socioeconomic groups are heterogeneous in their nature (Borsdorf & Hidalgo, 2013). Housing programs by MINVU in the current state do not consider any contextual or cultural interpretations of the residents in their planning instruments. Planning for housing is resulting in houses only, not keeping in mind that well designed multi-functional and multi-cultural community centers, parks and other public spaces play a vital role that goes beyond housing and caters to the needs of individuals as well as groups.

Diversity in Urban Form

Socially and economically mixed neighbourhoods consistently identify in urban form as key factors in sustaining diversity. This includes different proprietorship; owner versus renter, diverse typologies; a mix of different forms and sizes, single-family, multi-family, young couples, elderly persons etc. In addition, some research has indicated that stable diverse neighbourhoods are strengthened by the economic diversity of commercial areas and the existence of '*Social Seams*' in the form of schools, parks, or neighbourhood stores (Pascaris, 2012).

The economic model of Chile promotes homogeneity of spatial form and occupation on many levels, however, in this study the focus of diversity will be in two aspects. First, the diversity in housing typologies, since different typologies of housing will cater to different groups of people. Second, is the aspect of land-use, since the expansion of cities does not consider mixed land-use; citizens are working, accessing facilities, and finding opportunities for recreation far from their homes. This phenomenon overall concentrates active nodes of the city in one part, crippling access, and opportunity for the rest of the city.

Figure 1
Location of Valdivia and Osorno in Regions of Los Ríos and Region of Los Lagos



The principles of accessibility, vitality and diversity have been carefully chosen for this study, in relation to the effects that are visible as results of planning. Inaccessibility of services and facilities has ended up in segregation of spatial and social patterns, and non-diverse land-use and housing typologies have ended up collecting similar economic tiers in bubbles. It is important to mention that while it was essential to consider the diversity of economic tiers in this study, unfortunately, due to the limitation to access of data it had to be foregone.

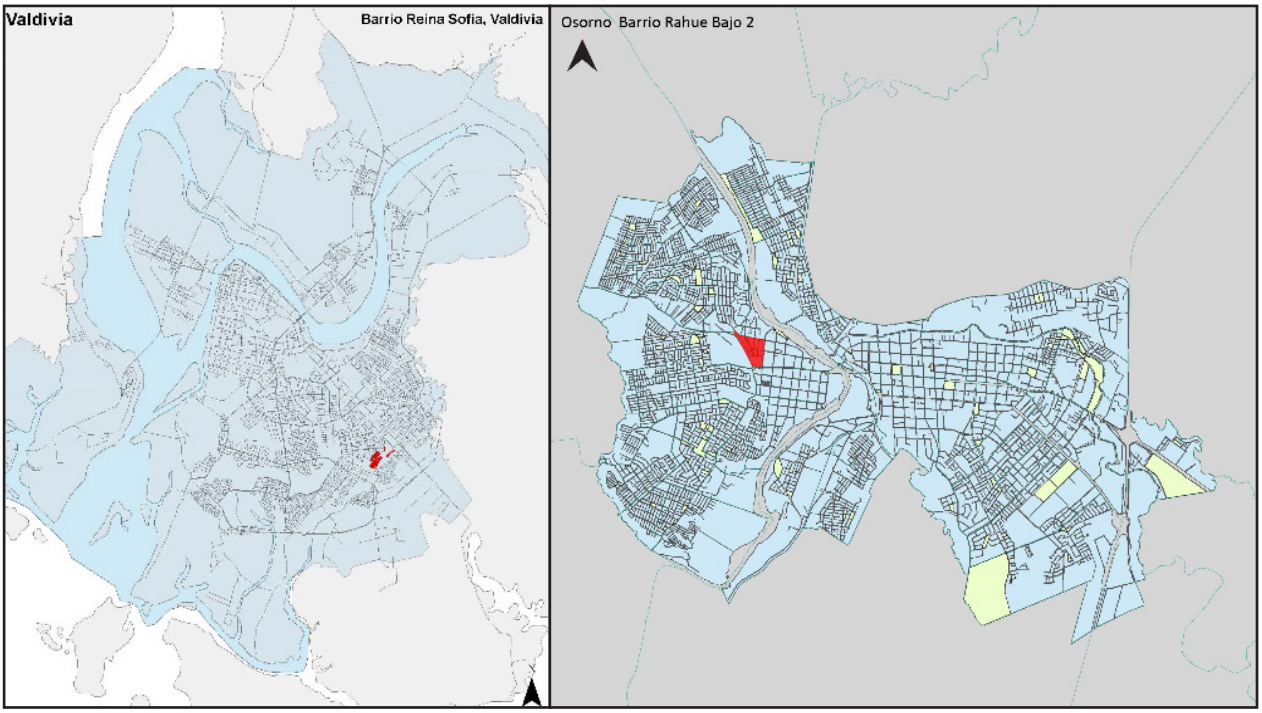
Material and Methods

Case Studies

The selected case studies for this research are neighbourhoods which are part of intermediate or mid-sized cities in southern Chile. Mid-sized cities today represent a great range of potential and interest from local governments for promoting sustainable urban development encouraging principles of urban form. Both studies show parts of these principles, which are key to address urban transformations, towards more socially sustainable neighbourhoods. To assess and evaluate planning principles of sustainable urban form, the study was conducted in two neighbourhoods: one implemented by CORVI in 1960 in Rahue Bajo 2, Osorno, and the other by SERVIU in Reina Sofia, Valdivia, from 2000s onwards. Osorno and Valdivia are both mid-sized Chilean cities located in Region X and XIV and have shown transformations and urban expansion patterns. Both cases have existed for a few decades, with their urban planning and form showing lives as results of social life.

Rahue Bajo 2 lies in the centre-west of Osorno, encompassing two main Streets: República and Bellavista, with a total area of 7.9 hectares. The neighbourhood dates to the 1950s, when the city's expansion was set to solve the increasing housing demand. The neighbourhood plan was designed under CORVI, and inculcated principles gearing towards values of quality of life. This housing program includes schools, medical centres, and sports fields, among other amenities within a radius of 500 metres of the neighbourhood. The neighbourhood has a population of 820 persons, according to Census 2017. 60% of the neighbourhood is economically active between the ages of 15-64. The neighbourhood has a total of 9 residential blocks, with 332 housing units of four different typologies; Row houses consist of 52%

Figure 2
Location of neighbourhoods in Reina Sofia, Valdivia and Rahue Bajo 2, Osorno



of the neighbourhood, apartment blocks with 17 % of the houses, single houses with 16%, and semi-attached with 15% of the total houses. The program by CORVI which was implemented in Rahue Bajo 2 had a short life span, however, this gives the opportunity to study and evaluate whether the morphological elements within the neighbourhoods have a positive, or negative effect on the quality of life of its residents.

Reina Sofia is located at the south-eastern periphery of Valdivia, and takes its name from the wetland Reina Sofia, around and on which it is built. The social housing in Reina Sofia developed in two phases; at first, under the Basic Housing Program in 1999, which was established to cater to the housing deficit in Chile, and was successful in providing basic housing to low-income citizens. The second phase was developed in 2014, in a typical cookie cutter style of private developers. However, neither the first nor the second phase includes any principles of planning for a sustainable quality of life. The area on which housing is developed is a wetland, and 20 years ago this area had a flourishing ecosystem with local flora fauna. Unfortunately, currently only a small percentage remains as a wetland due to rapid construction on it. The neighbourhood has a total area of 7.67 hectares, and a population of approximately 790 persons. According to the census 2017, 65% of the population is economically active between the ages of 16–64. Majority of the population density is between 151 and 300 per hectare, which in comparison to the rest of the city is high. According to the population density of Valdivia, it is observed that in the centre the density is as low as 50–100 person per hectare, and towards the periphery of the city the population density increases, which is a consequence of the housing models at the periphery. The neighbourhood consists of two housing typologies: 67% row houses and 33% separate (Instituto Nacional de Estadísticas de Chile [INE], 2017). Land use of the neighbourhood consists of two kiosks: a football field and a neighbourhood park. A general trend seen in Valdivia and recorded by MINVU is that the more at the periphery the housing, the farther away from services it is. Medical services, schools, and commercial areas are outside the walking range of the neighbourhood. Reina Sofia is a typical example of how social housing is implemented in Chile today, and due to the lack of morphological principles in the neighbourhood, the study can prove whether there is a positive or negative effect in the quality of life of the residents.

Table 1
Dimensions of sustainable urban form, how these are explored and measured
Source: author, based on Talen (2011) and Simpson's Index

Dimension	Elements to measure	Methodology	Unit of Research	Method of Conduction	Survey / Interview	Results (quantitative & qualitative -final)
Accessibility	Accessibility (availability & walkability) to basic retail, social services and public amenities.	People Following (Talen 2008)	Houses .Blocks .Neighbor-hood	. Survey with residents .Interviews with government officials, academics & practitioners .Report Analysis	Where & how do you go for: basic necessities (Eggs, meat, vegetables), recreation, school, work & medical service	Documents of: Availability of retail, social services & public amenities. Accessibility within walking range to retail, social services & public amenities.
Vitality	Presence and use of social and commercial nodes from home within walkable distance.	Gate Method - Static snapshot Method (Vaughan, 2001)	3 nodes in each neighborhood (Commercial + Social)	Field work Observation of patterns and movement. Recording three times per day. 12 hours of data collected during Tuesdays, Saturday and Sundays.	Observatory survey to track movements of vehicles & people in each node	Maps with patterns of movement of people. Matrixes, and charts with counts of people and vehicles. Qualitative results and maps with the patterns of activities and densities of use of people.
Diversity	Diversity of housing typologies, land-use & population density. (Simpson's Index)	Census on Density population Land-use map	Houses Plots Blocks Nodes	Secondary data collection via: ERIS GIS Census 2017 Maps from MINVU Primary data: Survey Mapping	Survey with MINVU	Graphic information (maps, charts) with the information of the metric density Analysis diversity of socio-economic conditions, land-use, blocks and plot sizes

The methods to assess conditions of sustainability; accessibility, vitality and diversity will be conducted via qualitative and quantitative methods, used by the community of *Space Syntax* to assess whether the urban form of neighbourhoods contributes to an improved quality of life (Talen, 2011; Vreeker, 2004. Accessibility is measured based on the distance between residential lots and services through *People Following* surveys, Vitality is measured based on a combination of *Gate Method and Snapshot Method,* and Diversity is measured based on land-use maps and housing typologies through *Simpson's Index*. To measure accessibility, a door-to-door survey was conducted of both neighbourhoods, for which 60% of housing units were chosen from each block in the neighbourhood. The 60% was based on a random systematic sampling method. To assess vitality, data was collected from commercial and social areas of the neighbourhood. In Rahue Bajo 2 data was collected from one commercial and two social nodes, and in Reina Sofia data was collected from one social and two commercial nodes, within a radius of 200–500 meters, hence three nodes in each neighbourhood were chosen for data collection. To assess diversity, the data on plot/block sizes, population and housing densities and land-use map for the neighbourhood was acquired from primary data collection and secondary sources.

Results

Accessibility

According to the survey results, between 80–90% of residents of Rahue Bajo 2 use the services available within the neighbourhood. The survey also shows that 90% of the residents access these services by walking, and only 10% who go outside use automobiles; 22% of the residents go to work nearby, while 22% of the households work outside the accessible distance, and the remaining 46% of households responded as not working. 38% of the population access school near the neighbourhood while 31% are going outside the neighbourhood, in this case, the majority are university going population. Whereas 31% of the households responded that they do not have school-going ages in their house. The above-mentioned services that lie within the accessible area of the neighbourhood are concentrated in a mixed-use area, stitched to the southern part of the neighbourhood, and is also considered as an important point of attraction or a pull factor. Being considered as a commercial node, it is not only serving the needs of the neighbourhood but also of the adjacent neighbourhoods, and eventually the city, pulling inflows of people. The accessibility factor in this neighbourhood is tied to an active living environment,

Figure 3
Radius showing distance of walkable accessibility to services in each neighbourhood

in which pedestrian access to daily life needs can be observed. Here, in practice can be understood what Talen (2011) explains as walkable access to services as an essential part of the sustainability equation, where people living in well-serviced locations will tend to have lower carbon emissions, and higher access to opportunities, lower the transport costs.

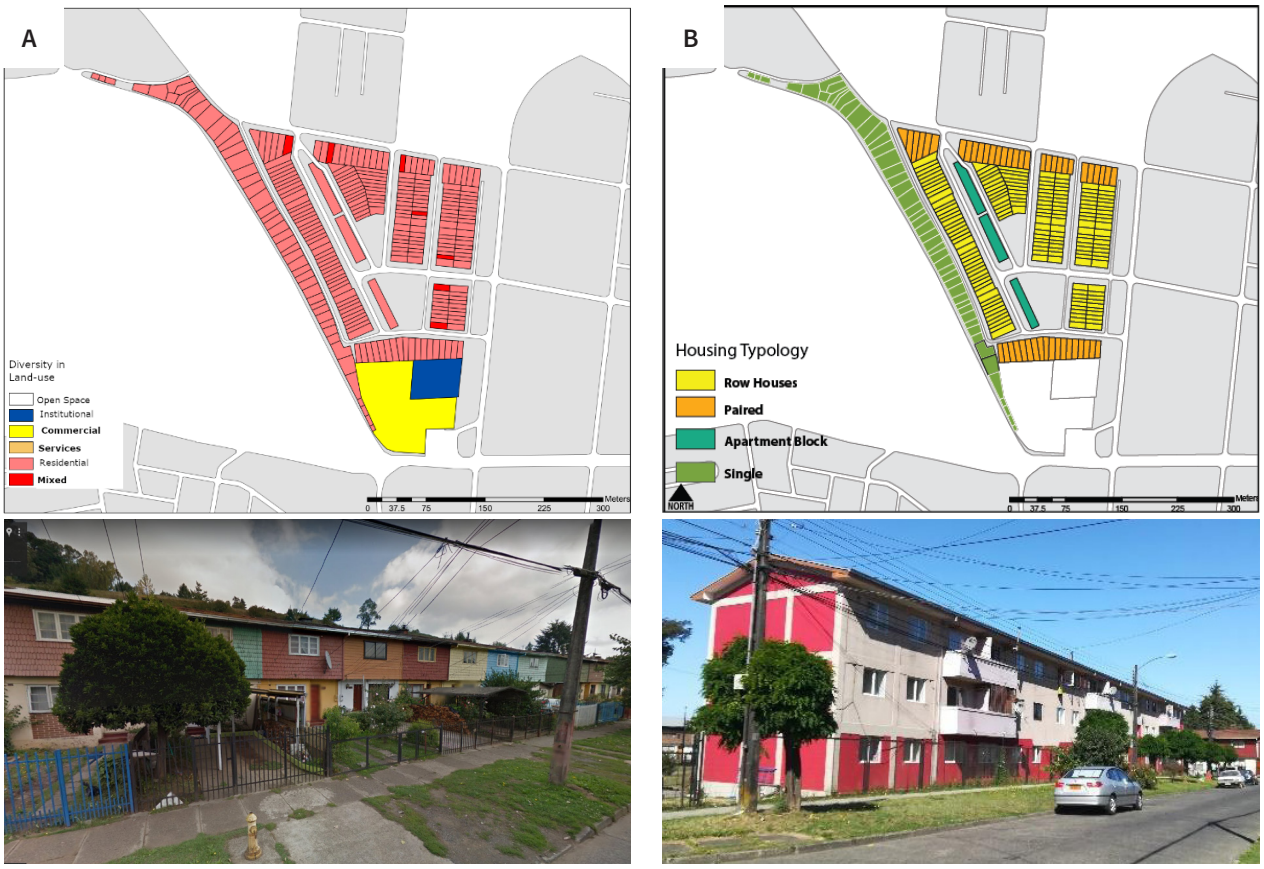
In Reina Sofia, and according to the summary of the survey, it is concluded that to buy basic goods, 85–95% of households' travel outside the neighbourhood, via public or private transport. For recreation, which includes parks and public spaces, only 13% of the households use neighbourhood spaces while 52% go outside the neighbourhood via vehicular mode, and 35% of the neighbourhood responded as not going for recreation at all. For work and school only 11–12% have close access, 42–44% go outside the accessible distance, and 44 to 45% responded as not accessing work or school. It can be concluded that most of the basic services are not present within accessible distance of the neighbourhood and hence almost 90% of the households travel outside the neighbourhood via vehicular transport to access basic goods.

Vitality

Out of the three nodes chosen in Rahue Bajo 2, Node 1 can be categorized as a commercial node and consists of a range of commercial activities like grocery stores, eateries, a gas station, a bank and a pharmacy. Services and amenities like a community centre and a medical clinic are also present in this node. It has the highest vehicular traffic with an average of 270 cars passing by, and 400 persons involved in different activities in the recorded time. Node 2 recorded 30 cars in the observed time, and the number of people passing was approximately 200. Overall, this node has the character of a courtyard, bringing in all the surrounding blocks together, and opening to different views of the neighbourhood. The activity of the node is supported by a local shop, hence the combination of commerce with an open space/park in front of it gives people a sense of place-ness. Elements like the local shop and the water tank serve as landmarks of space as discussed by Giddings (2007), and help in forming architectural associations, and points of recognition for the cognitive memory of people. In Node 3, the vehicular and pedestrian movement observed was 90 and 350 subsequently. Similar to Node 2, the activity of this node is also supported by a local shop. Road Juan Esteban Montero that stitches to the southern border of the node has a bus stop only 100 m from the node.

In Reina Sofia, Node 1 was recorded to have a total number of 130 pedestrian and 150 vehicular movements in the recorded period. Due to the local shop situated in this node, there are people observed walking in and out, however, the level of interaction is generally low, as 100 people were recorded interacting during the period of

Figure 4
Diversity of land use and housing typologies in Rahue Bajo 2



Note. A - Map showing land use diversity, RB 2. B - Map showing diversity in housing typologies, RB 2.

observation. Overall, the spatial condition of the node is noted to be of low quality, with no urban furniture, broken sidewalks, and very few trees. Node 2 recorded to have 40 pedestrian and 5 vehicular movements in the recorded period, showing the lowest level of activity in the neighbourhood. Since it is inside the neighbourhood with tertiary roads surrounding it, it can be evaluated that a low level of vehicular movement will be present, but considering it is the only park in the neighbourhood, it has extremely low levels of vitality. The general condition of the park was observed to have a low quality of urban elements, with unmaintained flora, no urban furniture and mud surfaces. Node 3 is the most active node of the neighbourhood with 280 pedestrian and 240 vehicular movements in the recorded time. It also recorded the highest number of interactions, especially during the weekend. Both Saturday and Sunday showed high levels of interaction among adults, and children in the node. Even though this node is primarily a football field people use this as a public space to have picnics, play sports, and do recreational activities during weekends. By observation, the node can be said to have a poor quality of urban facilities, with damaged playground equipment and garbage dumped at many spots in the node.

Diversity

In Rahue Bajo 2 the land use diversity was calculated to be 60%, according to the Simpson's Index. The neighbourhood has five different types of land uses including mixed-use, social services, urban facilities, residential and small-scale commerce. Seven small scale commercial shops are evenly spread throughout the neighbourhood mostly used by the residents, while the mixed-use node located at the southern tip of the neighbourhood plays the role of a hot spot, attracting people from outside the neighbourhood. A variety of programs including educational, social and cultural programs are present. The school apart from its educational purpose also hosts community programs such as local food exchange and

Figure 5
Diversity of land use and housing typologies in Reina Sofia

Note. A - Map showing land use diversity, Reina Sofia. B - Map showing diversity in housing typologies, Reina Sofia. C - Singular houses in Reina Sofia.

musical events. The second aspect to assess diversity was the housing typology, which measured 71% with four different types of housing, including row houses, paired houses, singular houses, and apartment blocks. The typologies are also of varying heights, the houses are single and double stories, while the apartment blocks are three stories high.

Discussion and Conclusion

In terms of Accessibility, residents of Rahue Bajo 2 have adapted to a walkability trend, which is enhanced by the positive quality of morphological planning and urban elements such as sidewalks, trees along sidewalks, and benches. This situation helps residents in taking internal routes to access commercial and social nodes, keeping the overall atmosphere of the neighbourhood active. It supports how Moore & Wright (2017) describes active living and the factors which can play a role in having sustainable communities. As residents do not have to travel a long distance, the effect is economically, environmentally, and salubriously viable. Ultimately the accessibility element as part of the planning process in Rahue Bajo 2 is intending towards a holistically sustainable lifestyle. Which according to Green et al. (2005) stresses the well-being of human and environmental health.

On the other hand, in Reina Sofia, the norm is to access services outside the neighbourhood, hence, a vehicular-dependent population is observed. To buy basic goods there are two types of trends observed in Reina Sofia. First, the residents have changed their consumption patterns according to the neoliberal mode of development in Chile, by purchasing all food items under a single, massive

scale supermarket, where all items are processed, packed and available. This phenomenon has been observed in depth by Özler (2011) in cities like Santiago, where the current mode of planning cities pushes the already vulnerable into poverty, it is now in evidence observed in mid-sized cities as well.

The second trend is still attached to a more traditional nature, but at the same time proving the unease and fragmentation of services. Chilean society through the years has consumed food items from temporary markets called *Ferias*, which have available many fresh food items like fruits, vegetables and meat, with varying seasonal varieties and opportunities for different vendors. This trend is still followed by many residents in Reina Sofia; however, the new housing planning patterns do not allow these markets to be set up in the neighbourhoods since they lack the element of adaptability in the built form. In Reina Sofia, the plot sizes of the whole neighbourhood are identical and built upon, having no open space that can allow multi-functionality or diversity of use.

As Borsdorf and Hidalgo (2013) discusses, fragmentation of services in Chile has increased the inequality among different socio-economic groups, which is a major factor in unsustainable communities, and for residents of Reina Sofia this fragmentation is a living reality. A 35% of households in Reina Sofia forego recreational activities due to the inaccessibility of space in the neighbourhood, and the long distance to these spaces outside the neighbourhood. It can be noticed what Salinas Varela and Pérez Bustamante (2011) discussed in depth, that segregation through housing or planning highlights the role in shaping outcomes that are devoid of socially, economically, and environmentally balanced neighbourhoods.

In terms of vitality, the most active nodes in both neighbourhoods are situated towards the outskirts of the neighbourhoods, suggesting that the seam line of the neighbourhood can have the tendency to be more active than the interiors. In Rahue Bajo 2 the most active time in the week was recorded to be on Tuesday evenings. Since it is a commercial node that is also used by adjacent neighbourhoods, the after-work hours on weekdays for commercial use might affect the flow of people. In Reina Sofia the most active time was recorded on Saturday evenings, as this node is essentially a social node, hence, weekend evenings might affect its use. Some residents were seen extending recreational activities in the streets, suggesting that the need for social spaces is demanded. Both cases confirm what Williams (2005) and Qi Zhang (2018) discourse that having residential blocks built around various scales and uses of nodes, can enhance the social interaction of a neighbourhood, and serve as a pull factor not only for the neighbourhood but for the city as well (Qi Zhang, 2018; Williams, 2005).

The least active node in Rahue Bajo 2 is Node 2 recorded to have 250 pedestrians while the least active node in Reina Sofia has around 70 persons. Even though the location of both nodes is morphologically the same, meaning both are the inner most nodes within the neighbourhood surrounded by residential blocks and are supported by a local shop, yet the difference is three times. The first reason could be that, in Rahue Bajo 2 the least active node is surrounded by six residential blocks of varying housing typologies, while in Reina Sofia only three blocks surround the node, hence the population density is higher in Rahue which according to Inzulza-Contardo and Gatica-Araya (2018) can help generate a greater number of people in nodes. The second reason can be what Jacobs (1989) explains about the morphological arrangement of blocks, which can help in having eyes on the street. Since this node is situated in the middle of varying sizes and heights of residential blocks, there is an outside-in element present, which can preserve the idea of safety. While in Reina Sofia, the three blocks are of the same housing typology, and the population density is between 50 to 90 persons per hectare.

In terms of Vitality, the sustainable urban form in Rahue Bajo 2, has a distinctive ontological hierarchy of public spaces. The idea of vitality can be an important principle to consider in local planning, to seek small-scale interventions, in strategically located nodes, for wider effect towards community cohesion. This hints towards the importance and interdependence

Table 2
Matrix showing activity levels of most representative nodes in Rahue Bajo 2 and Reina Sofia

Neighbourhood	Node	Representative snapshot	Intensity of use	Type of activity		Temporality of use
Rahue Bajo 2	1	Tuesday Evening	310	Walking	172	Very High
				Eating	25	
				Interacting	74	
				Buying/selling	4	
				Playing	35	
	2	Tuesday Evening	94	Walking	54	High
				Eating	2	
				Interacting	16	
				Buying/selling	9	
				Playing	13	
	3	Tuesday Evening	112	Walking	39	High
				Eating	3	
				Interacting	25	
				Buying/selling	20	
				Playing	25	
Neighbourhood	**Node**	**Representative snapshot**	**Intensity of use**	**Type of activity**		**Temporality of use**
Reina Sofia	1	Tuesday Evening	42	Walking	26	Low
				Smoking	3	
				Interacting	5	
				Buying/selling	5	
				Playing	3	
	2	Sunday Morning	14	Walking	9	Very Low
				Smoking	0	
				Interacting	2	
				Buying/selling	3	
				Playing	0	
	3	Saturday Evening	119	Walking	42	High
				Smoking	9	
				Interacting	43	
				Buying/selling	0	
				Playing	25	

Very High (199- 400) High (65 - 190) Low (35 - 65) Very Low (1 - 35)

of morphological principles, here vitality is directly dependent on accessibility. In terms of diversity, the comparison of diversity in the two neighbourhoods through land use and housing typology considers six socio-spatial events, which are land use, economic exchange, spaces for social opportunities, neighbourhood programs, integrated transport system and neighbourhood interfaces. In Rahue Bajo 2, the land use diversity is evaluated to be 60% and due to the diversity of the above-mentioned socio-spatial events, there are cultural and social trends observed. In Reina Sofia with only 6 % of land use diversity, it was observed that residents experience a low level of spatial events and fragmented social bonds.

In terms of diversity, it is important to consider the location of these hotspots. Whereas, in RB2 the areas are distributed throughout the neighbourhoods, in Reina Sofia they are located to the south, close to each other.

Table 3
Showing diversity of different categories in Rahue Bajo 2 and Reina Sofia

Rahue Bajo	Category	Diversity Index	Reina Sofia	Category	Diversity Index
	Land use	0.77		Land use	0.06
	Housing Typology	0.71		Housing Typology	0.47
	Population Density	0.77		Population Density	0.53
	Houing Density	0.77		Houing Density	0.74
	No of Floor	0.58		No of Floor	0.10

Diversity in land use also enhances different interfaces to connect with the neighbourhood as observed in Rahue Bajo 2, the neighbourhood is interacting with the city through the interface of mix-use, which also serves as a buffer between the neighbourhood and the city. On the other hand, in Reina Sofia, there are a series of similar residential neighbourhoods one after the other, hence, the landscape of Reina Sofia remains monotonous for approximately 1.5 kilometers before connecting to the main avenue of the city. Rahue Bajo 2 spatially contains three kinds of connected interfaces. The residential connects with the mixed-use node which connects with the city and vice versa. The mixed-use nodes behave as a transitional interface and a buffer, between the residential area and the city, and this event is supported by a connected public transport network that cuts through the neighbourhood. Overall, the neighbourhood can be understood as the opposite of what Scheer (2001) calls the static tissue of the city. Instead, it can be understood as a flare or fluid tissue due to the diversity of the above-mentioned socio-spatial events which are integrated with one another.

Housing Typology is evaluated to be more diverse in Rahue Bajo 2, automatically affecting the diversity in housing density and population density in each block, a factor that Posner and Zingales (2009) mention in his analysis of American societies, that the more diverse the housing typology, the more diverse is the population and housing density, as different typologies can host a range of people that have different family types. Having diverse well-designed housing typologies with public squares, courtyards and other spaces for interaction can increase the chance of social sustainability, and landmarks for cognitive recognition as is discussed by Ian Thomas MacDonald in his book *Unions and the City*, 2017. Aspects mentioned in his book are relatable in Rahue Bajo 2, where a sense of utilizing corners, sidewalks, flower beds and surfaces of buildings is present. Whereas, in Reina Sofia with the monotony of space, it becomes harder to make associations and connections with spatial elements.

A limitation necessary to mention regarding measuring diversity with Simpson's Index on a neighbourhood level is that it can often produce results that in number might seem legit, but in reality, the story might vary. As an example, the diversity in the Housing Typology of Reina Sofia is recorded to be 47%, even though this number can be considered fairly in the range of medium-scale diversity, it is essentially a limitation of the methodology. Since the Simpson Index considers the total number of elements to calculate diversity, in this case, the total number of housing typologies is 2, and out of 2 typologies, there is a 47% chance of having either one of the two typologies. Simpson's Index might better work in an area that is bigger than a neighbourhood unit, for instance, a sector where there is a wide range of categories to measure from, for example, the studies Kajtazi (2007) conducted in the sector of Fushe Kosovo or Vreeker (2004) to evaluate diversity in Dutch cities.

Conclusions

This research has evaluated the sustainable potentials of the built environment in two social housing neighbourhoods by assessing three aspects in urban form, with the aim to propose sustainable tools for local level planning.

Neighbourhoods with accessibility to services and basic needs contribute to a sustainable lifestyle, not only for the neighbourhood but also for the sustainability of the city. This has been motivated by a concern over the effects of the built environment on physical activity, and human health by understanding what Talen & Koschinsky (2011) discussed, that walking, and overall physical activity is vital for sustainable lifestyles, and accessibility as a planning principle is a necessary precondition for urban, economic, social, and ecological sustenance.

In terms of vitality, this research shows that even though both neighbourhoods have almost the same number of people residing, Rahue Bajo 2 is highly active in terms of pedestrian and interactive vitality on streets and

squares. This is what Lawson (2014) and Meenashki (2011) discuss, that urban enclosures within neighbourhoods can have a vibrant tendency due to their morphological form, function and quality. While on the other hand, the overall vitality is low in Reina Sofia due to the model of social housing in Chile, which enforces trends of car dependency, cutting off associations and networks of social interaction, which Qi Zhang (2018) describes is important to form social production of space.

Finally, the concept of diversity as a planning tool becomes important as mixed housing typology and mixed land use complements in increasing activity levels of the neighbourhood, and as Jacobs (1989) describes, can become a complex pool of use, within neighbourhoods for social sustainability. Diversity in population density as a planning tool can also help in urban compositions of different population groups, mitigating disruptive social impacts and promoting inclusion. However, it depends on how well the national policy relates to the local context. Without a national regime that is committed to equity, heightened competitiveness of a particular city will likely only produce polarization, and diversity may result in rivalry rather than tolerance. If, however, it becomes the template for local development, rather than the formula to justify the negative aspects of current social housing programs, it can provide a physical framework for a city that offers a higher quality of life to its residents.

Based on the aforesaid, this article suggests some general recommendations to be developed as planning instruments for social housing neighbourhoods in Chilean cities to promote sustainable urban form.

General recommendation includes the following

- PLADECO[1] (Communal Development Plan) should include an approach towards the neighbourhood concept and its scale, including land-use, population, and housing densities, open vs. built spaces and the connectivity to the areas where services are concentrated.
- Considering the importance of neighbourhoods in the expansion of the city, and due to its scale, there is a possibility of a new planning instrument as a planning guide, at the local level for social housing and housing in general. Since PRC[2](The Regulatory Plan) focuses on a communal level, it does not include specifics of planning all-inclusive living that adheres to sustainable conditions. This planning instrument can include:
  - Integrated principles of morphological form that contribute to the equity of basic needs and services for residents in social housing neighbourhoods.
  - Public participation in depth through the formation of neighbourhood communities and platforms for residents to be an active part in conceiving, formulating, and implementing the development of neighbourhoods.
  - Horizontally and vertically engage with the overall vision of PLADECO, PRC and other planning documents.
  - Focus on implementing urban morphological elements as principles customized to each context, and not replicate social housing programs as models.
  - A long-term vision and short-term evaluations that address how these principles will result in affecting the social quality of life in neighbourhoods, focusing on critical issues such as accessibility to basic necessities, education, health and recreational facilities.
  - A road map should be established that can guide change step by step, from exclusion to interaction to cohesion of the morphological principles.

1 PLADECO is a guiding instrument of development on the communal level. It focuses on actions oriented to satisfy the needs of the local community and promote its social, economic and cultural advance.

2 The Regulatory Plan is an instrument constituted by a set of rules on adequate hygiene and safety conditions in buildings and urban spaces, and comfort in the functional relationship between housing, work, equipment and recreation areas.

- Development plans of all scales need to vertically and horizontally coordinate with one another and across sections. National, Regional, Communal, Sectoral and local (neighbourhood level) plans need to be synchronized.

Implications for Future Studies

Since the objective of this research was to compare sustainable urban form and propose a planning tool for social housing neighborhoods, it did not focus in-depth on proposing interventions for the existing neighborhoods. An important aspect for future studies is to take these principles in consideration for retrofitting within neighborhoods of mid-sized Chilean cities.

Having only three principles of urban sustainable form, might not holistically sustain neighbourhoods. Principles of adaptability, density and connectivity need to overlap with accessibility, vitality, and diversity. All principles of urban form might even conflict with one another; hence it is the role of a planner to combine those that complement one another in a particular context.

Lastly, due to limitations of the data acquired, this research had to forego the analysis of diversity in socio-economic groups and its association through these principles for a better quality of life. This is a very important element to consider in evaluating the quality of life in urban forms, as the precarious conditions of low-income socioeconomic groups is an important element to consider in sustainable and just cities. [44]

References

Billig, M. (2005). Sense of Place in the Neighborhood, in Locations of Urban Revitalization. *GeoJournal, 64*(2), 117–130. https://doi.org/10.1007/s10708-005-4094-z

Borsdorf, A., & Hidalgo, R. (2013). Revitalization and Tugurization in the Historical Centre of Santiago de Chile. *Cities*, 31, 96–104. https://doi.org/10.1016/j.cities.2012.09.005

Briggs, J. (2005). The Use of Indigenous Knowledge in Development: Problemas and Challenges, *5*(2), 99-144. https://doi.org/10.1191/1464993405ps105oa

Cáceres Seguel, C. (2015). Ciudades satélites periurbanas en Santiago de Chile: paradojas entre la satisfacción residencial y precariedad económica del periurbanita de clase media. *Revista INVI, 30*(85), 83–110. https://doi.org/10.4067/s0718-83582015000300003

Demiddel, S. F. y Pérez Bustamante, L. (2009). Más que una suma de casas: la Unidad Vecinal Villa San Pedro de Coronel. *Revista INVI, 24*(67). https://doi.org/10.4067/s0718-83582009000300005

Giddings, B. (May, 14-17 2007). *The Role of Urban Design in Public Space* [Conference session]. CIB World Building Congress, Cape Town, South Africa.

Green, G., Grimsley, M., & Stafford, B. (2005). *The Dynamics of Neighbourhood Sustainability.* Joseph Rowntree Foundation.

Guzmán-Concha, C. (2017). Chilean Neoliberalism under Scrutiny: Class, Power, and Conflict Are Back in Town. *Latin American Research Review, 52*(1), 183–189. https://doi.org/10.25222/larr.96

Holm, D.E., Murray, M., & Pauw, C.J. (September, 27-30 2005). *The House as a Satisfier for Human Needs: a Framework for Analysis, Impact Measurement and Design* [Conference session]. XXXIII IAHS World Congress Housing "Transforming Housing Environments through Design", University of Pretoria, South Africa.

Instituto Nacional de Estadísticas de Chile, INE (2017). Censo Nacional de Población y Vivienda, https://geoine-ine.chile.opendata.arcgis.com/datasets/54e0c40680054efaabeb9d53b09e1e7a_0/explore?location=-39.850447%2C-73.223061%2C13.72

Inzulza-Contardo, J., & Gatica-Araya, P. (2018). Subsidiary Displacement and Empty Plots: Dilemmas of Original Residents and Newcomers in the Reconstruction of Talca, Chile 2010–2016. *Urban Studies, 56*(10), 2040–2057. https://doi.org/10.1177/0042098018787967

Jacobs, J. (1989). *The Death and Life of Great American Cities.* Random House.

Jirón, P. y Cortés, A. (2004*). Análisis de la Política Habitacional Chilena y sus futuras orientaciones* (Documento de Trabajo N°4). INVI, Serie Documentos de Trabajo.

Kajtazi, B. (2007). *Measuring Multifunctionality of Urban Areas* [Thesis]. International Institute for GeoInformation Science, Enschede, The Netherlands.

Lawhon, L. L. (2009). The Neighborhood Unit: Physical Design or Physical Determinism? *Journal of Planning History, 8*(2), 111–132. https://doi.org/10.1177/1538513208327072

Lawhon L.L. (2014). Neighborhood Unit. In: Michalos A.C. (eds) Encyclopedia of Quality of Life and Well-Being Research. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_3335

Lynch, K. A. (1981). *The Image of the City.* MIT Press.

MacDonald, I. (Ed.). (2017). *Unions and the City: Negotiating Urban Change*. Cornell University Press. http://www.jstor.org/stable/10.7591/j.ctt1q8jhtc

Michelson, W. M. (1977). *Environmental choice, human behavior, and residential satisfaction*. Oxford University Press. https://doi.org/10.1177/016059767900300314

Meenakshi, S. (2011). Neighborhood Unit and its Conceptualization in the Contemporary Urban Context. https://www.researchgate.net/publication/340887219_Neighborhood_Unit_and_its_Conceptualization_in_the_Contemporary_Urban_Context

Moore, P., & Wright, S. (2017). *Implementing Context Sensitive Design on Multimodal Corridors: A Practitioner's Handbook*. Institute of Transportation Engineers (ITE).

Özler, Ş. İ. (2011). The Concertación and Homelessness in Chile*. Latin American Perspectives, 39*(4), 53–70. https://doi.org/10.1177/0094582x10397917

Pascaris, J. P. (2012). Healing Neighbourhoods through Urban Acupuncture. *Theses and Dissertations*. Paper 804. https://doi.org/10.32920/ryerson.14651664

Posner, E. A., & Zingales, L. (2009). A Loan Modification Approach to the Housing Crisis. *American Law and Economics Review, 11*(2), 575–607. https://doi.org/10.1093/aler/ahp019

Qi Zhang, E. H. (2018). Towards Sustainable Neighborhoods: Challenges and Opportunities for Neighborhood Planning in Transitional Urban China. *Sustainability, 10*(2). https://doi.org/10.3390/su10020406

Raposo, A. (1999). La vivienda social de la CORVI: un otro patrimonio. *Revista INVI, 14*(37), 41-73.

Salinas Varela, E. y Pérez Bustamante, L. (2011). Procesos urbanos recientes en el Área Metropolitana de Concepción: transformaciones morfológicas y tipologías de ocupación. *Revista de Geografía Norte Grande*, (49), 79-97. https://dx.doi.org/10.4067/S0718-34022011000200006

Scheer, B. C. (2001). The Anatomy of Sprawl. *Places, 14*(2), 28-37.

Song, Y., & Knaap, G.J. (2004). Measuring the Effects of Mixed Land Uses on Housing Values. *Regional Science and Urban Economics, 34*(6), 663–680. https://doi.org/10.1016/j.regsciurbeco.2004.02.003

Talen, E., & Kochinsky, J. (2011). Is subsidized housing in sustainable neighborhoods? Evidence from Chicago. Housing Policy Debate, *21*(1), 1-28. https://doi.org/10.1080/10511482.2010.533618

Tapia, R. (2005). Rodrigo Hidalgo: La vivienda social en Chile y la construcción del espacio urbano en el Santiago del siglo XX. *Revista EURE (Santiag*o), *31*(93). https://doi.org/10.4067/s0250-71612005009300009

Talen, E. (2008). New Urbanism, Social Equity, and the Challenge of Post-Katrina Rebuilding in Mississippi. *Journal of Planning Education and Research, 27*(3), 277–293. https://doi.org/10.1177/0739456x07301468

Talen, E. (2011). Sprawl Retrofit: Sustainable Urban Form in Unsustainable Places. *Environment and Planning B: Planning and Design, 38*(6), 952–978. https://doi.org/10.1068/b37048

Talmage, C., Hagen, B., Pijawka, D., & Nassar, C. (2018). Measuring Neighborhood Quality of Life: Placed-Based Sustainability Indicators in Freiburg, Germany. *Urban Science, 2*(4), 106. https://doi.org/10.3390/urbansci2040106

Vaughan, L. (2001). *Space Syntax Observation Manual*. UCL.

Vreeker, R. (2004). *Urban Multifunctional Land Use and Externalities*. In ERSA conference papers, European Regional Science Association. https://ideas.repec.org/p/wiw/wiwrsa/ersa04p346.html

Williams, K. (2001). Designing the City: Towards a more Sustainable Urban Form. *Urban design International, 6*(2), 116–117. https://doi.org/10.1057/palgrave.udi.9000045

Zumelzu-Scheel, A. (2016). Forma urbana y sostenibilidad: pasado, presente y desafíos. Una revisión. *AUS,* (20), 77–85. https://doi.org/10.4206/aus.2016.n20-12

Zumelzu, A., Gruehn, D., & Hosni, J. (2019). Assessment of Sustainability of the Built Environment in Latin American Neighbourhoods: Five Cases in Southern Chile. IOP Conference Series: Earth and Environmental Science, 297. https://doi.org/10.1088/1755-1315/297/1/012040