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ORIGINAL RESEARCH ARTICLE

Development of community sustainability assessment methods in medium-sized cities in Chile

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ABSTRACT

Urban research related to sustainability is going through a rich experimental stage to explore different methods to deal with the current and future impacts of climate change on cities. This poses new challenges to the redevelopment of urban areas. These challenges are particularly relevant at a time of major urban transformation in the global south. This paper aims to develop a method to explore and evaluate the sustainable potential of urban morphology in the surrounding areas of medium-sized cities. The method involves six criteria related to the sustainability of built environment: scale, accessibility, diversity, connectivity, density and node. This approach applies to a community in Temuco, southern Chile. The results show the importance of building adaptive capacity to generate use diversity, which in turn promotes greater sustainability of urban morphology. On the other hand, the high population and housing density in residential areas reduce the pedestrian capacity of indoor streets, while the vertical mixed use and the change of urban block density are still the best response to promote social interaction and high collective activities in urban space. This paper summarizes the operational value of this method and reflects on the progress made in promoting the more sustainable urban form development of medium-sized cities in southern Chile in the future.

Keywords: built environment; medium sized cities; sustainability; urban form

1. Introduction: Morphological changes of medium-sized cities

Since the second half of the 20th century, the concept of sustainability has become a key issue in urban design. The increased use of the term “sustainable” can be seen as a response to emerging issues such as climate change, increased oil use and the historic end of the “oil city” in the fossil fuel era[1]. Sustainability has become a “global concern” because of the impact of human intervention on the environment throughout history, especially in the period known as the Anthropocene, geological events in Earth history and human behavior have left a deep mark on the earth[2–4]. In the history of urban development, the Anthropocene is a period of modern industrial cities, which is consistent with the development of industrialization, population growth and urbanization globalization[5–7].

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and the Caribbean is the most urbanized developing region in the world. The urbanization rate rose from 41% in 1950 to 79% in 2010[8]. If this trend continues, almost all Latin American people will live in cities in 20 years (90%)[8]. As of 2012, the census results of Chilean cities showed that most of these cities were medium-sized, with a population of 100,000 to 300,000, almost half of the medium-sized cities in Latin America (48.1%)[9]. This panorama shows the accelerated social spatial and morphological changes and their impact experienced by Chilean cities in this century.

As for the definition of intermediate City, some authors agree that there is no consensus definition. Literature review shows that this concept varies by country, author or institution[10,11]. In Chile, the number of residents is used as a demarcation criterion[12,13], but this is still a limited criterion. In Chile, Maturana and Rojas[12] defined the concept of intermediate city related to intermediary, which is understood as the spatial function of a city in the territory and its ability to integrate into the urban system through its own social, economic and cultural construction[11]. Intermediary activities can be carried out around material and non-material factors, and the scale can also be from local to national or even international. The author believes that the concept of intermediate city appears as a related concept, because there are not enough quantitative or qualitative standards to determine a clear definition, so it is not easy to reflect.

Chile's medium-sized cities have evolved from compact to fragmented and expanding, and have experienced a growth process similar to that of the country's metropolises, where the way of living has changed significantly in the past few decades[11,14]. Its rapid growth and the dispersion of surrounding areas and the proliferation of new residential structures have a direct impact on urban lifestyles, forcing residents to redefine their social relations and identity[15–17].

Many authors address social, economic and territorial change by emphasizing the physical and morphological factors involved in these changes. For example, Salinas and Pérez[18] are characterized by morphological modifications to the continuity, compactness and boundary attributes of the urban historical model, resulting in the dispersion of cities.

On this basis, the literature research believes that the main factor of change is large-scale private housing projects, like the access control community in the United States, which have changed the landscape and urban lifestyle. These forms of exclusion and segregation have a long history in Chile and have been exacerbated by globalization and socio-economic transformation[19]. According to this idea, Atkinson believes that the evolution of our civilization in history is the "core" of the problem, because individualism has been adopted very early, which tends to believe that taking care of yourself is better than taking care of society itself[20,21]. In this regard, Atkinson pointed out two key aspects that are being pushed to the limit and important for urban planning: Suburban life and obsession with cars, both of which are the greatest manifestations of personal success. Compared with modern urban life, the population is gradually dispersed in suburban residential areas, and the relationship between people and cars is becoming closer and closer. Not only as a means of transportation of suburban lifestyle, but also as a tool of social self-expression, it has become the basis for greedy consumption of resources, especially energy.

Other studies have shown that these processes have produced new urban forms, which are mainly characterized by fragmentation and privatization, reducing social polarization and increasing small-scale isolation[19,22,23]. For example, Ruiz-Tagle, explaining the process of the emergence of these new forms, pointed out that in Chile, the focus of these studies was to emphasize the benefits of so-called "social diversity" communities aimed at strengthening functional communication, reducing stigmatization and encouraging the attraction of private services. However, although the implementation of this concept in Chile is still in its infancy, the author puts forward the difficulties of "social integration" of such communities, especially when

only one level the functional level can produce positive results in the overall context of urban fragmentation, regardless of isolation and inequality[24]. This is because the local coexistence of different social groups often leads to competitiveness and conflict. Most of today's urban structures are either abandoned or the population is getting smaller and smaller. This in turn is concentrated on the edge or new urban edge, which is becoming more and more obvious in medium-sized cities[25,26].

In view of this, the results of the structural adjustment of human settlements will largely depend on the evolution of attitudes, views and socio-political structural adjustment process, in which urban form plays a key role. The analysis of this phenomenon is complex, because the realization of a sustainable city should consider not only environmental factors, but also the social and spatial integration of residents, the economic support of the local environment and the attention to the built environment[14,27]. Such research is essential in Chile, which has experienced an important process of urbanization and transformation over the past few decades. Although there are initiatives to collect and assess information on the territory's cities, they remain isolated and do not produce methods for conducting research aimed at assessing the sustainability of the territory. Chilean cities, especially medium-sized cities, need small scale diagnosis to improve the efficiency and effectiveness of local management, because there is an increasingly urgent need to consider how to restructure and adjust our urban structure and built environment in order to achieve more sustainable urban development. These initiatives should aim to improve the morphological conditions of communities, understand their sustainability potential and weaknesses, and promote human development through these efforts to create the necessary conditions for sustainable social and economic development.

This paper aims to propose a methodology to deal with the complex process of transformation of medium-sized cities. The construction of the above method lays a foundation for verifying its application in specific cases that need to explore sustainability conditions. Considering that urban planning practices at the national level do not have tools or tools to do so, the contribution of this work is to assess how sustainability can be seen as an operational assessment tool for community urban forms, Especially in the medium-sized cities in southern Chile, these cities now have the greatest potential and interest in promoting urban development in a sustainable way[8,28]. The method is applicable to two transitional communities in Temuco, a city in central southern Chile. Finally, according to the research results, the operational value of this method and its significance in promoting the more sustainable urban form development of medium-sized urban communities are discussed.

2. Community is the basic unit of urban sustainable development

Over the past few decades, researchers have paid more and more attention to the community[29–31]. Some of them believe that they are the basic sustainable units of cities because they represent the link between cities and individuals[32,33]. The concept of neighborhood is defined as a shared interactive space[34,35]. From the perspective of morphology, communities have certain specific characteristics, which mark the special relationship with the whole city: forming a unique form, defining its hierarchy, combining activities, allowing the development of some functional autonomy, and establishing relevant social relations between their residents and territories.

At present, one of the challenges facing urban form is to strengthen the relationship between man and society, which can be used as a strategy of sustainable planning in the 21st century. This relationship complements the hierarchy related to urban spatial organizations (families, neighborhoods, communities, regions) and the forms of social and civil organizations (from families to urban communities). This partnership between space and social organizations sees the region as the basic "sustainable unit" of cities[36,37]. Various studies and authors

agree that the three main needs of cities need to be reflected in the urban microstructure: accessibility, proximity or proximity, and the mixing or diversity of functions[6,38,39]. Similarly, in the urban microstructure, an important theme is place, which is traditionally understood as "neighborhood" in planning. The concept of neighborhood is considered as the reference point of the whole urban community. From the perspective of morphology, it has some characteristics, which mark its special relationship with the whole city: (1) form a unique form and define its personality; (2) the combination of one or more activities allows the development of certain functional autonomy; (3) establish meaningful social relations between their inhabitants and the territories they occupy[35,40]. In this regard, Blanco[40] mentioned a key aspect of slum construction, that is, the close relationship between material and society[37]. The author mentions that one function of the community is recognized, which distinguishes it from the general consumption of the city. In addition, Gravano said, "this function is mainly residential and related to industrial, commercial and cultural functions, which constitute a broader category, such as lifestyle"[41(p255)]. Therefore, neighborhood relations will be an urban social concept, representing an "urban microstructure" the connection between cities and individuals[40(p73)].

3. Sustainability criteria related to urban form

The term "urban form" is only used to describe the physical characteristics of a city and is usually defined as: "Spatial allocation of static elements in urban design"[42(p21)]. Urban form is closely related to the problem of scale, which is also described as: "Morphological attributes of all scales in urban areas"[27,43]. The analysis of features is different from a highly localized scale: building materials and facade; Broader scope: housing type, street type and its spatial organization or lotus[44,45]. However, when we refer to sustainability, urban form is not only related to the physical characteristics of urban space, but also includes non-tangible aspects, such as density or modality, which in turn are related to the shaping of social environment and its interaction within communities or residential areas[46,47]. This inclusive view between users is an important part of today's concept of sustainable urban form.

The definition and measurement of sustainable urban morphology has made significant progress and development in the past 20 years[39,47–53]. This challenge has prompted international and local governments, planners and architects to propose a new framework for structural adjustment and redesign in urban areas in order to achieve sustainability. These problems have been solved at different spatial levels.

In developing the following sustainability assessment methods, considering the scientific literature, continue to use the standard method. For methodological purposes, the following six methods were selected. This address sustainability as a holistic and operational tool from urban form, as they need to affect urban sustainability and human behavior. This will help to study and understand the components of urban form and its relationship with human interaction in urban space and environment, which is of great significance for urban design decision-making in a more sustainable environment.

3.1. Atmospheric scale

Caniggia and Maffei define the scale as: "Different levels of complexity of components arranged internally to build a whole"[54(p245)]. In the field of human geography, scale is often confused with level and size[55–57]. However, the concept of scale as a level only refers to the more complex and broader scale. For Howitt[58], scale is not size and level, but a relational element in a complex mixture, which also includes space, place and environment. On the other hand, Kärrolm took the concept of scale as an analytical concept to deal with the different complexity of influencing factors[59]. However, the impact of different complexity can be seen as different scales. For example, when discussing and analyzing the impact of a community, if we discuss it from the

perspective of city or region, the results of this discussion will be different.

The scales that can be considered or measured include personal buildings, blocks, blocks, regions and cities. These spatial classification levels affect the measurement, analysis and understanding of urban morphology. In this regard, block or street block is the basic element of urban material structure. There is little literature to support the view that smaller blocks usually provide more space for human interaction than larger or longer blocks and better adapt to some aspects of urban development[60–62]. For example, Leon Krier believes that the blocks of small cities have produced greater diversity and complexity in the urban landscape. For Krier, the length and width of blocks must be as small as possible; They should form as many clearly defined streets and squares as possible in the form of a multi-directional horizontal pattern of urban space[63]. According to Jacob, shorter block pieces will allow more contact and interaction between people. It shows that the frequency of street intersections (or more street intersections) contributes to the different pedestrian quality of a street: "Streets with one entrance per 300 feet (90 meters) are easy to find, and some of the best streets are close to this number, but there are more entrances on the busiest streets"[64(p302)]. In the literature, people agree that the indicators of "good" operation show that blocks between 60–70 m are very suitable for pedestrians, blocks between 100 meters are very suitable for pedestrians, and blocks of 200 m or more are very inconvenient to promote pedestrian flow.

3.2. Accessibility

It is an integral part of the long-term Accessibility Theory[64–66]. From the perspective of accessibility, sustainable urban form refers to the extent to which sustainable urban form adapts to the needs of pedestrians and cyclists, rather than the needs of car drivers, due to the impact of the built environment on people's physical activities and health. It is believed that pedestrian oriented streets will not only affect the quality of places, but also the degree to which people are willing to walk[47]. Sustainable settlement models should increase opportunities among residents, their workplaces and services they need equally, especially for those with displacement the elderly, the disabled, pregnant women, car free families[39]. In this sense, accessibility is related to the principles of intelligent growth and active living environment, in which pedestrians' access to basic daily life needs is regarded as a basic aspect[48,67]. Accessibility measures have recently been used as part of efforts to assess the health impact of the built environment[37,38,68]. Walking access to services and equipment is an important component of urban sustainability, as people living in service places within walking distance tend to reduce mobility dependent on cars and produce a lower carbon footprint[69].

3.3. Connectivity

Urban morphology plays a key role in promoting or limiting connectivity. Connectivity refers to the extent to which the local environment provides connectivity and focal points (for people and resources) for all sizes and uses. This quality promotes sustainability because higher connectivity leads to higher levels of interaction between people and environmental, social, economic and cultural activities, all of which are considered to improve the stability and collectivity of communities or communities in the long term[47,52]. Social connections at the neighborhood level are seen as a walking phenomenon, in which the "neighborhood relationship" network is linked to the interconnected pedestrian streets and the internal channels of the neighborhood generated by these street networks[64]. The importance of maximizing urban spatial connectivity has always been a common theme in urban morphology research, which focuses on maximizing opportunities for interaction and communication, and increasing the number of routes through route areas streets, sidewalks and other routes[57,70]. According to various studies, it is generally believed that large block, dead end and tree street systems are unlikely to provide good connectivity[71,72].

3.4. Bone density

Density is an important part of urban sustainable development. This standard has always been one of the main factors in maintaining pedestrians' access to the basic services and equipment needed by the community. It is well known that the increase of carbon emissions reduces the increase of density and mixed use[73]. However, there are no specific rules on how density forms or mixed-use levels should change in different regions and contexts[47]. The literature on communities generally identifies the following values: population size between 4,000 and 10,000, total population density between 50 and 58 HAB/ha, and net housing density between 43 and 85 VIV/ha[38,42]. The average housing density should reflect and exclude local conditions and realities. These may vary depending on local housing conditions adjacent to the edge or center of the community in order to support the development of local services and equipment within the community.

3.5. Diversity

For Talen[52], diversity as a dimension of sustainable urban form involves two aspects. First, the diversity of land use understood as a balance between residential and nonresidential land development is related to promoting many benefits: Economic vitality, social interaction between users, and the provision of services and equipment needed by communities on foot[67,68]. Second, socially diverse communities continue to be seen as models for achieving the goals of community well-being and social equity[24,74], in which case sustainable relationships are achieved through a combination of income, race and ethnic groups because people "believe" that these are the basis of "truly" sustainable communities. At this level, it is also pointed out that the diversity and mixing of housing unit types is also an important aspect in a territory, whether it is single family housing, row housing, collective housing, etc. The study of social mixed communities through users and types accordingly identifies urban morphology as a key factor of Sustainable Diversity[42,48,75].

3.6. Nodal property

This element is closely related to the issue of scale and the idea that urban development should be organized around nodes at different levels and scales[39,57,76]. Although expansion tends to divide territory, sustainable urban forms often have an obvious hierarchy: from regional growth nodes to block centers, and even public spaces at the block level. At the community level, nodes promote the sustainability of urban form by providing public spaces, which are the organization of buildings, although not necessarily the place for all shops, local services and social interaction. The activity nodes concentrated at the community level can provide the physical connection of the community by providing a common destination for the surrounding residents. This is to understand the way people interact in various scales of space. These spaces support other aspects of sustainable urbanization, such as the increase in surrounding density, the mixing of housing types anchored by concentrated spaces, or the feasibility of community scale commerce[34,47,77].

4. Materials and methods

4.1. Evaluation method of urban form sustainability

Figure 1 outlines the methodological structure for assessing and measuring sustainability. In order to study the sustainability of the urban form of Monteverde and Llaima villa areas on the German Avenue, the nodes providing vitality were determined. In order to measure the node degree, the space occupancy intensity is calculated by the observation gate method of Space Syntax[78] theory to measure the average number of cars and people moving in the space. The results are represented by proxy mapping performed using Depthmap software. Specifically, the density is measured by calculating the total population density and net housing density, considering a group of blocks near the activity node of each community. According to the

method proposed by Emily Talen[47], accessibility is measured by calculating the residential plot within 500 m near the service and business district, divided by the extended area. Connectivity is measured by the number of intersections per unit area through analysis using Depthmap software. Diversity is calculated through the Simpson's diversity index commonly used in ecology, which is adapted by Talen[52] to measure diversity in communities and quantify habitat diversity, taking into account the number of units and the abundance of each unit in the territory. In this study, diversity was determined according to the type of housing unit and the socio-economic group of the community.

Finally, when evaluating the scale, the static dimension of community physical environment is considered. Therefore, according to Oliveira[60], the size of street facade and its impact on human activities were measured. According to the author, the evaluation of the block includes the block group defined by the GIS method of dividing the block into "natural cracks" according to the width of the front of the block. People want to get different values from reality, that is, which places may be more sustainable in urban form than others.

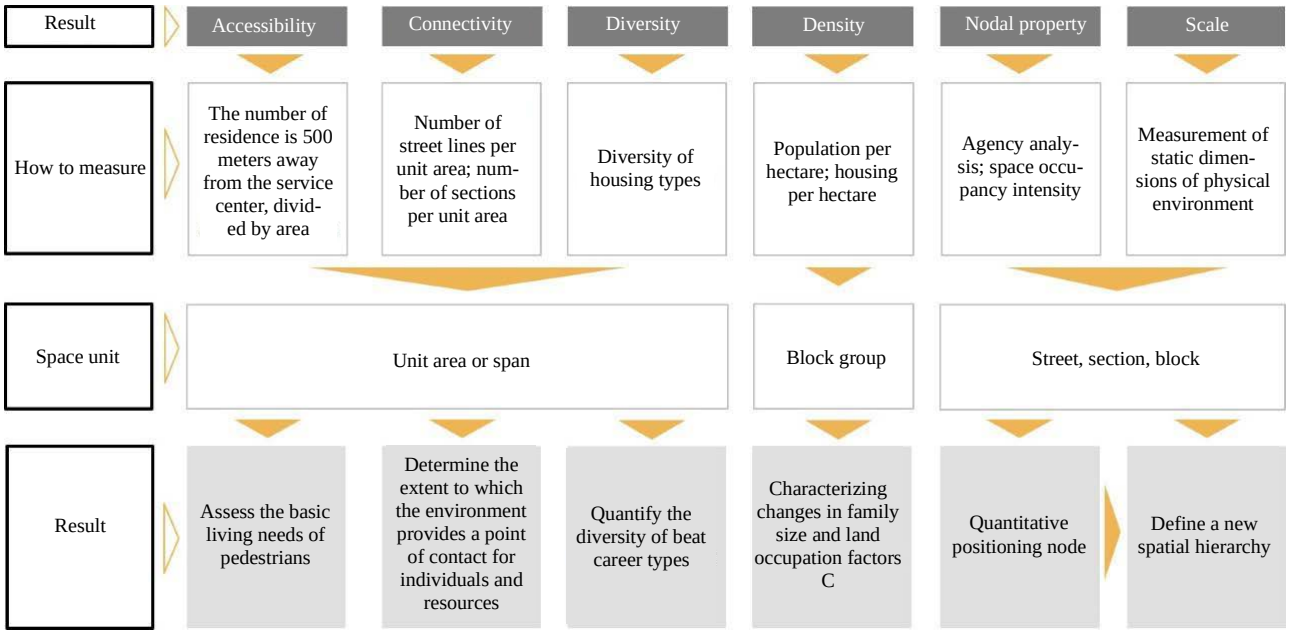

Figure 1. Measurement method of urban form sustainability.

Source: Authors.

4.2. Case study

The study of the sustainable potential of urban forms is based on a case study of two communities located in the German Boulevard district west of Temuco, as it is an area that has experienced significant spatial changes since the beginning of the 20th century[79]. The two case studies involved the Monteverde and Llaima communities (**Figure 2**).

Llaima or villa Llaima emerged through the Corvi project in 1968 as a 15 ha community serving the middle and lower classes. It emphasizes the important balance of its land use, 70% for residential and 30% for nonresidential. Its overall structure is divided into paired, collective and collective housing types, with a total of 376 housing units. There is a central urban center in Llaima Town, which gathers community green space, primary school, church and local commercial facilities in a mixed area with collective housing. The scheme proposes two common parking spaces to make streets and passages for pedestrian activities. Due to the presence of the Autonomous University of Chile in the region[80], most of the paired houses in the whole region have been transformed to produce student huts (second rental houses).

Figure 2. Monteverde and Llaima communities in Temuco, Chile.

Source: Authors.

Next to Ilema is Monteverde, which was built through the covey plan in the 1960s. Monteverde is located north of St. Martin street, between Javiera Carrera and the Andes. It is characterized by high average occupancy rate, which is completely composed of one-story paired houses. The modular street is divided into north south and east west directions. Montevideo has two public indoor squares, a community headquarters, a children's garden and a business center, which are located on one of the squares with green areas. In terms of use, the area continues to be dominated by houses, but some houses on the edge of St. Martin street and Andes street have been changed from typology to commercial use. In this regard, it should also be emphasized that within the community, some houses have been converted to commercial purposes, but the original type has always been maintained.

Table 1. Five measures for sustainable urban form in Temuco Monteverde and Llaima communities

Measures	Barrios	
	Monteverde	Llaima
Node (pedestrian intensity, average weekly)	427	2,704
Population density	128	111
Housing density	35	50
Accessibility	0.35	0.55
Connectivity	7	4
Diversity (average diversity of housing types and socio-economic groups)	0.44	0.65

Source: Authors.

Table 2. Average street elevation size of Monteverde and Llaima blocks

Barrios	Maximum (m)	Minimum (m)	Median (m)
Montevideo (19 blocks)	175.6	43	91.8
Llaima (21 blocks)	220	20	89.4

Source: Authors.

5. Result

The assessment of sustainability criteria is shown in **Table 1**, which shows the results in numbers. **Table 2** shows the measurement of the scalar pattern of the analyzed neighborhood. Therefore, various observations can be made on these data.

Firstly, the results show that the most sustainable areas do not seem to have much relationship with potential nodes, which have higher load and higher use intensity. On the contrary, they are related to places with more mixed building uses and more diverse node activities, especially open spaces such as squares and green spaces, rather than high intensity streets.

Second, in two communities with high total

population density, the density gradient between their blocks is larger, providing more types and housing sizes. This promotes the functional exchange of active nodes, mainly in Llaima and Monteverde square, and increases the opportunities for pedestrians to obtain opportunities and services. In terms of net worth, there are two kinds of density: vertical density and horizontal density. The vertical density has the greatest positive impact, especially near Llaima. In contrast, due to the growth of rental housing in Monteverde residential area, the high-level housing density reduces the pedestrian accessibility of indoor streets.

It can be easily reached in places with high housing density, mixed use and small blocks, such as Llaima. In contrast, in Montevideo, pedestrian accessibility is reduced in places with high horizontal density of housing due to the expanded impact on public space. The blind wall, the disappearance of the front garden, the low distance between the front of the street, the lack of green space on the internal street and the reduction of the size of the sidewalk will have an adverse impact on the route selection, thus affecting the accessibility of pedestrians. In addition, the routes with the highest pedestrian accessibility on record were observed on streets composed of blocks with short street facade dimensions, with an average of no more than 100 meters. These routes have a high-quality architectural environment in all categories, from wide sidewalks, the presence of green areas and high-quality commercial and service infrastructure, such as Plaza Llaima node (**Figure 3** and **Figure 4**).

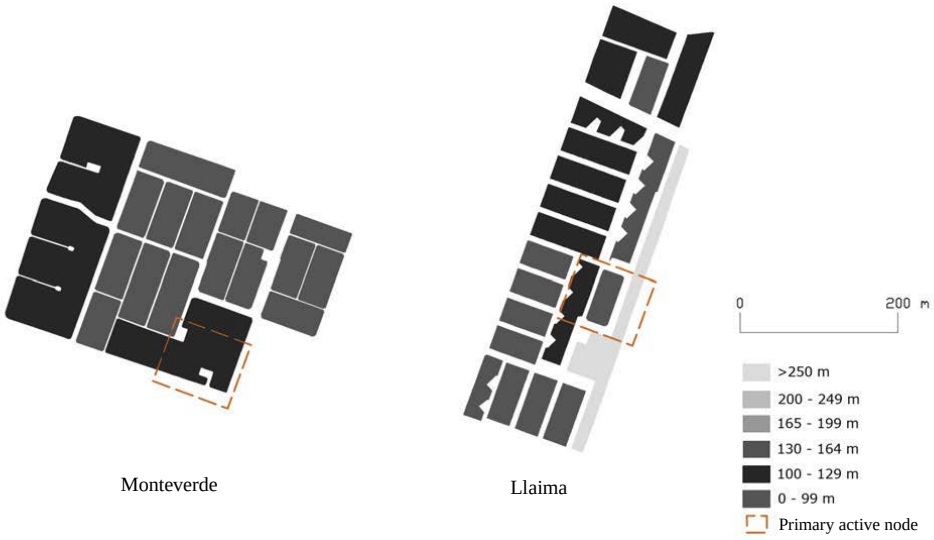

Figure 3. Calculation of street facade dimensions in Llaima and Monteverde towns, Temuco City, Chile.
Source: Authors.

In terms of diversity, most different regions are usually located in regions with higher connectivity and nodes with higher diversity of use, such as the nodes of Plaza Llaima. They show more equal average diversity values between the two categories analyzed: Housing types and socio-economic groups. This “diversified” community provides positive functional exchanges by promoting more effective access to opportunities, goods and services. In addition, socio-economic groups (each block) are more differentiated, especially where the use of buildings is more complex, which is achieved through the continuous housing types providing services on the first floor or the adaptability of existing buildings (existing type conversion) to new uses. The mix of Vivien Da types and combinations of different shapes and sizes provide multiple opportunities to enter these communities. For example, in Monteverde and Llaima communities, the arrival of immigrants and college students created opportunities, leading to the emergence of new services and local economies. In these areas, mainly in Llaima, commercial activities coexist with residential facilities, and rental properties not only provide

greater purchase options, but also are crucial to retaining low-income people.

Socio economic diversity is related to the development of the local economy, which is a basic psychological factor of the observed morphological adaptability, especially in the Llaima population. These economies are linked to retail, fruit and grocery stores, strengthening and promoting social interaction and increasing the temporary nature of public space. This mainly occurs in open and more visible places, such as Llaima square, which increases the opportunities for social interaction between people. This has led to the emergence of local economies that have changed the construction use of housing without changing the original type, while maintaining the readability and size of the block.

Figure 4. The route with the highest walking accessibility recorded among the population of Llaima in Temuco, Chile.
Source: Authors.

Figure 5. The house continues to be commercially renovated on the first floor.

Source: Authors.

Figure 6. Montevideo district is an area with high three-dimensional score of urban form sustainability.
Source: Authors.

Figure 7. Areas with high scores in the three dimensions of urban form sustainability are in Llaima district.
Source: Authors.

6. Discussion

The maps in **Figure 6** and **Figure 7** show the most sustainable places in the community, where there is a greater balance between values.

In these places, the architectural form is more adaptable to new uses. In these places, local daily activities are promoted in the community structure (grocery stores, bakeries, fruit stores, small restaurants, local businesses and green spaces). In addition, places with the greatest potential for sustainable development occur around nodes that promote greater diversity of activities and functions. This mainly occurs in open places with high visibility. The condition is to increase the opportunities for interaction between people, increase the timeliness of meetings, and maintain the scale and architectural readability of the community. In turn, increase opportunities and resources within the unit. This situation can be well observed in Llaima square and Monteverde square (**Figure 8** and **Figure 9**).

On the other hand, places that tend to be unsustainable or low sustainability are places with low diversity of socio-economic groups, types and housing scale. These places are often single functional areas with barrier free pedestrians and high

horizontal density. On the most densely used streets, such as German Avenue and St. Martin street, land use has changed with the emergence of services, shops and equipment. This change in use resulted in the loss of building adaptability and increased the size of the original batch to make way for new types and nonfunctional buildings. With the emergence of this phenomenon, the community has lost its original architectural scale and readability, creating opportunities for social interaction in the space, but the use burden related to cars and purchasing resources is greater. This is observed in Alemania Ave. and Andes St., mainly on the edge of Llaima district. In a single-family type unit with horizontal spatial distribution, the housing density is high, which is related to the low diversity of land use. This density has a negative impact on the quality of public space, which affects the travel of pedestrians and reduces the possibility of pedestrians entering the community. This was seen in Montevideo.

Figure 8. Llaima Square.

Source: Authors.

Figure 9. Monteverde's active nodes score high in the three-dimensional shape of the city.

Source: Authors.

7. Conclusions

This paper analyzes six standards of sustainable urban form, which together constitute a methodology to deal with the complex process of medium-sized urban transformation, and deal with sustainability as a whole and operable concept from the perspective of urban form. The method is applied to two communities under transformation in Temuko city. Although the results of this paper cannot be summarized, the business value of this method must be emphasized, which allows the concept of sustainability to be quantified by identifying criteria for locations with greater sustainability potential. The effectiveness and superiority of this method are proved in practical application. An important advantage is that this approach emphasizes the importance of the SOS maintainability concept as a tool, in which the advantage of the concept is to integrate the concept to solve urban problems. This integration is not to produce indicators, but to explore the specific conditions of urban

development. Therefore, it must be recognized that the sustainability criteria discussed only define the basic qualities that all communities and cities must have to ensure that the basic needs of their residents are met. There are many other human needs and aspirations related to sustainability that can be included.

Regarding its application, it was concluded that no block was more sustainable than another block in all categories or levels analyzed. On the contrary, there are some specific sites in the units analyzed, and the values of these sites show that the sustainability potential is greater due to the special situation of urban development. The place with the greatest potential for sustainable development is mainly related to two factors: first, the use of community buildings is more mixed, the diversity of node activities is greater, and it faces open space rather than high load and high-intensity streets. Second, the mixed use and high-density change of blocks are still the best answer to promote social life and high space collective activities. On the other hand, adaptability to use seems to be a basic feature of urban environments, which tend to be more sustainable. There are several types of cities in which Lima has a high degree of sustainability. It is characterized by the integrity of structure and function, the high diversity of functions and activities, and greater adaptability to the use of urban food. Another related aspect is that they have a geographical center, which is spatially defined as an open space, whether square or green space, composed of various uses. Finally, they do not show the spatial closure caused by the sudden change of their block size, nor do they keep a distance from more general roads. In this sense, the neighborhood image generated by these two spaces is in sharp contrast to the population form established in Chile in the past few decades. These populations are only based on a series of housing and do not include the design principles that recognize individual, family and collective activities as the basic standard of neighborhood development.

Sustainability basically means sustainability. The scope of sustainable urban design is particularly broad because it includes not only the sustainability of the natural environment, but also the sustainability of the surrounding environment: Location, community and economy. This paper suggests that the initiatives related to the design of urban communities in Chile should, on the one hand, aim to improve the morphological conditions and give play to their potential and weaknesses in sustainability, on the other hand, promote human development and create the necessary conditions for sustainable social and economic development.

Conflict of interest

The authors declare no conflict of interest.

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