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Exploring the spatial structure of dense housing estates in a highly unequal metropolis

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ABSTRACT

Residential density and accessibility are essential aspects of urban sustainability. Well-planned cities allow people to access to services and goods in an efficient manner in relatively dense housing schemes, but how do these two aspects interact? This article investigates the inner spatial structure of the housing estates and their integration with the rest of the city. It reports the axial and visual analyses of nine housing estates located in different parts of Santiago de Chile; a city that almost eradicated severe forms of deprivation, but has socio-spatial segregation together with profound inequalities.

The analysis shows that the housing estates located in disadvantaged areas have labyrinthine and highly segregated spatial structures. Conversely, the inner structures of the housing estates located in wealthy areas are, in general, well-integrated. Moreover, the comparison between the original and the current situation of the housing estates shows that the proliferation of irregular house expansions, gates and fences have reinforced frontiers and fragmented otherwise large open spaces devoted to the community. On the contrary, those housing estates that are in well-off areas have, to a great extent, preserved their structures over time.

The findings indicates that the fragmentation and the spatial arrangement observed in the housing estates located in disadvantaged areas may strengthen the dichotomy between the interior and the exterior, fuelling the—already high—perception of insecurity in Santiago. Furthermore, the contrasting trajectory of the housing estates according to their socioeconomic background suggests that the existing schemes to "densify" underprivileged areas need to be redressed.

KEYWORDS

Space Syntax, Axial Analysis, Visual Analysis, Dense Housing Estates, Santiago de Chile.

1   INTRODUCTION

An abundant body of research has demonstrated that residential density and accessibility are essential aspects of urban sustainability (Cheng *et al.*, 2007; Wachsmuth *et al.*, 2016; Næss *et al.*, 2019). Numerous studies have highlighted the relevance of developing cities with residential density that allows the provision of urban services and equipment accessible to all (Cervero & Kockelman, 1997; Handy *et al.*, 2002; Forsyth *et al.*, 2007; Ewing & Cervero, 2010; Cervero *et al.*, 2012; Gim, 2012). Other studies have emphasised the role accessibility plays in the wellbeing and quality of life of the population (Atkinson, 1998; Church *et al.*, 2000; Kenyon *et al.*, 2003; Cass *et al.*, 2005; Levitas, 2007; Preston, 2009; Stanley *et al.*, 2011). Meanwhile, an emerging body of work has investigated the intricate relationship between density, accessibility, the life of the cities and people's experiences and perceptions (Næss, 2015; 2016; Stefansdottir *et al.*, 2019; Figueroa *et al.*, 2019).

The pioneer works of Jacobs (1961), Gehl (1987), Whyte (1988) and other scholars (Appleyard, 1980; Jacobs, 1995) have suggested that dense and diverse cities create vibrant and safer public spaces. A number of authors have demonstrated that accessibility plays a key role in the way in which people perceive others, arguing that places with limited connection with the rest of the city fuel the distrust towards strangers. The opposite case, an accessible place, dilutes frontiers and collaborates in the creation of more diverse public spaces (Aalbers, 2003; Grant & Mittelsteadt, 2004; Blandy, 2007; Figueroa *et al.*, 2019).

On the other hand, residential estates aim to provide prolongations of their private houses in collective spaces shared by the community, where households share their everyday life within a certain familiarity that provides them with a sense of community and wellbeing. For this to happen an essential condition is the perception of safety. This is especially important in densified neighbourhoods where dwellers do not have the luxury of private gardens, many times share a limited private area and are located in central areas of the city where there is an active urban life with mix use, traffic and multiple passers-by. The multiple, and sometimes contradictory requirements, of collective spaces are expressed in very different spatial configurations, which, in general terms, tend to aim for a delicate equilibrium between the private and the public space, the flow and restriction of non-inhabitants of as well as visual control from within allowing for privacy at the same time.

This article seeks to address these issues by investigating the inner spatial structure of dense housing estates and their integration with the rest of the city. To do so, the article adheres to

Space Syntax theory which, conceived by Hillier and Hanson (1984) and further developed by others (Hillier, 1996; Penn *et al*., 1998; Hanson, 2000; Penn, 2003; Bafna, 2003; Varoudis & Penn, 2015; Peponis *et al*., 2017), indicates that there is an intricate relationship between the configuration of urban space and the development of the community. The article reports the axial and visual analyses of housing estates that have distinctive urban layouts. It examines nine cases located in Santiago de Chile that illustrate the many forms in which the State has addressed the issues of housing and densification—and explores important intervening variables, the patterns of segregation and the many inequalities, from which this metropolis and other Latin American cities suffer (Rodríguez & Winchester, 2001; De Mattos, 2002; Sabatini & Brain, 2008; Ruiz-Tagle, 2016; Fuentes *et al*., 2017).

Excluding this introduction, this article is structured in three sections. Section 2 provides details of the methods outlined earlier and the nine housing estates. Section 3 reports the main findings and is subdivided in two subsections that cover the results of the (i) axial and (ii) visual analyses of the housing estates. Lastly, Section 4 summarises the main conclusions of the analysis carried out.

2   DATASETS AND METHODS

To address the aims outlined earlier, this article reports the findings of the syntactic analysis of nine housing estates built between 1959 and 2012. Structured in 4 to 5 story block apartments and over 10 story residential towers, those housing estates have densified the area where they are located and have distinctive layouts (Figure 1). Moreover, they represent different stages of Chilean housing policies:

- **Case A** (*Sector 3 Población Juan Antonio Ríos*, 1959) and **Case B** (*Villa Frei*, 1964) were built during an era of beneficiary state housing policies, where a minimum of urban equipment was included in the estate. Case A is a sequence of L-shaped five-storey block apartments surrounding sports facilities and open areas for the community. Case B combines four and five stories block apartments with towers over fifteen storeys scattered across a large green area. Both cases were designed following the precepts of modern architecture and are also part of the first Chilean efforts to renovate and densify well-located urban land through large denser redevelopments (Figure 1).

- **Case C** (*Remodelación Inés de Suárez*, 1971) and **Case D** (*Remodelación San Cristóbal*, 1971) were built during a short socialist democratic government, with a stronger emphasis in strengthening the community through a system of collective applications to the dwellings, as well as including collective spaces and equipment within the estate. Case C is a housing estate of three towers of over twenty storeys each, and four lower buildings connected by a commercial podium. Case D is arranged in three parallel sections. The central section includes a large public space surrounded by

facilities where two residential towers are located. The two lateral sections are occupied by four-storey block apartments and two-storey single-family houses that enclose collective gardens with restricted yet public access. Like the previous housing estates, cases C and D are also inspired by modern architecture and, as such, have large open spaces and elevated walkways and terraces. Both cases are close to the city centre and were built directly by the State.

- **Case E** (*Villa Los Sauces,* 1982) was built during the dictatorship (1973-1989), where access to the dwellings was by individual families through a subsidy system. It comprises fourteen square-shaped urban blocks that have three-storey townhouses in the borders and communal gardens in the centres. This case is located in the low-income residential periphery of Santiago and is often described as a "novel solution" built during a period in which the State delegated the construction of housing to private actors.

- **Cases F** (*Conjunto Bustamante*, 1940) and **Case G** (*Santiago Centro Magno*, 2008) are small developments in the central area of the city, with common spaces and facilities located inside and were built by the private sector, although both under very different housing policy: the first under a beneficiary and the second under a subsidiary system. Case F is a four-storey apartment building and Case G is a residential tower of seventeen storeys.

- **Case H** (*Villa Altas Cumbres*, 2003) and **Case I** (*Villa Lomas de Lo Prado*, 2009) were built during the new neo-liberal democracy and were part of programs that aimed to provide new alternatives to low-income groups (Case H) or relocated communities living in highly deteriorated housing estates (Case I). Both cases consist of four-storey block apartments. In Case H, the C-shaped apartment buildings are arranged in the borders of the housing estate; in pairs enclosing communal gardens. In Case I, the buildings are located in the borders of the blocks, creating inner spaces occupied by green areas and facilities. Case I also has single-family houses. Both estates are in the periphery of the city.

The location of the cases illustrates the patterns of segregation that the city suffers (Figure 2). Cases B, C, F and G are located in the centre or wealthy northeast of the city. All deprived groups were eradicated form this area during the dictatorship, and today it concentrates the majority of the job sources, facilities and services available in the city (Tokman, 2006; Figueroa *et al*., 2018). Cases A and D are located in in an old industrial belt that cocoons the historic central area. This belt suffered a profound decline during the second half of the past century but has been revitalised in recent years by the combination of urban renovation programs and private investment. Finally, Cases E, H and I are part of the deprived and homogenous residential periphery which, built under the umbrella of social housing policies, is immersed in a complex process of physical and social deterioration (Ducci, 1997; Márquez, 2004; Rodríguez &

Sugranyes, 2004). Table 1 summarises the main features of the nine cases and Figure 2 shows their location in Santiago.

Case A   Case B   Case C

Case D   Case E   Case F

Case G   Case H   Case I
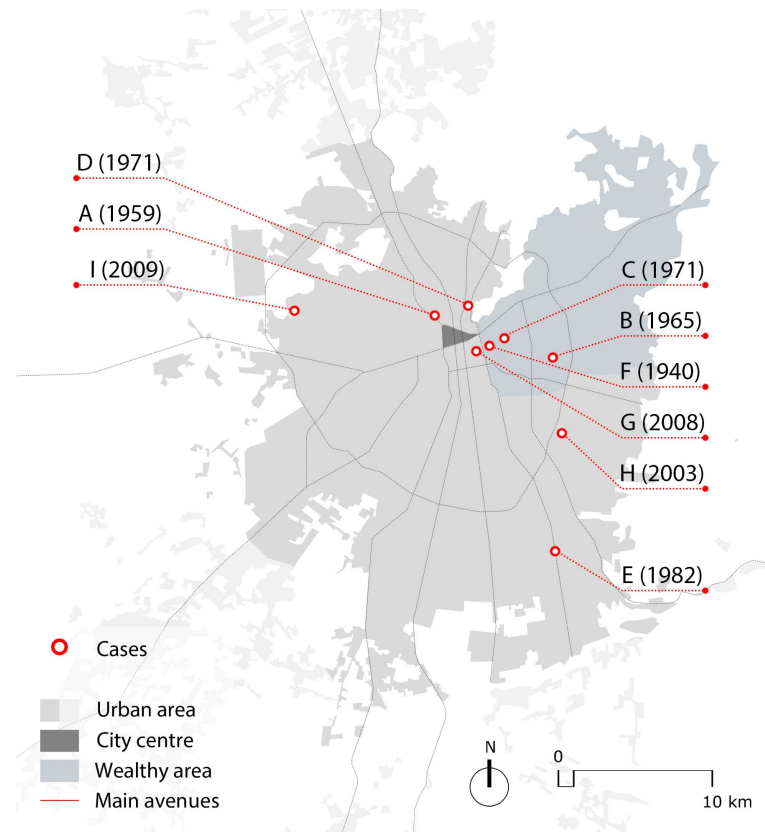

Figure 1: Selected housing estates.

Figure 2: Location of the cases.

Case (year of construction)	Area (ha)	Density (people/ha)	Number of units	Distance from city centre (km)
A (1959)	5,1	371	475	1,4
B (1964)	11,25	288	1080	6,6
C (1971)	6,7	320	716	3,4
D (1971)	2,08	379	263	2,2
E (1982)	11,6	292	864	15,7
F (1940)	0,55	471	87	1,9
G (2008)	0,40	3026	343	1,3
H (2003)	6,42	451	964	9,9
I (2009)	11,53	240	922	10

Table 1: Summary of the cases.

The analysis involved drawing an axial map of Santiago (79,895 lines) and imported into the software DephtmapX (version 0.8.0). Using the features of the software (Axial Analysis), the map was analysed to obtain the Global Integration (HH) and the Local Integration (r3) of the whole system and each housing estate. The nine cases and their surroundings (a circumference of 1,5 km diameter from the centre of the housing estate) were later isolated into smaller axial maps and imported into the software to obtain the aforementioned integrations (i.e., HH, r3). In parallel, the original and current situations of the cases were drawn in detail, giving particular attention to those elements that may have changed the configuration and visibility over the years

(e.g., irregular house enlargements, opaque fences). Like the axial maps, the detailed maps were also imported into *DepthMapX* to calculate, this time, the visual integration of the public spaces. The research team also visited the nine housing estates, registering significant features in photographs and field notes, and conducted thirty-two semi-structured interviews in which local leaders were invited to talk about the housing estates where they live. The interviewees were asked about (i) the trajectory of the housing estates, (ii) their level of satisfaction with its features, (iii) the management of the public and communal spaces and (iv) their patterns of use, (vi) the walking conditions and (vii) the impacts of the COVID-19 pandemic on the public life and the community. With the consent of the participants, the interviews were tape recorded, transcribed and later analysed with the assistance of the qualitative data analysis computer software *atlas.ti* (version 8.0). The main results of the interviews are being published elsewhere and are used in this article to support particularly relevant matters of the syntactic analysis.

The following sections report the main results of the syntactic analyses described earlier. In detail, those sections cover (i) the axial analysis or how distinctive layouts have strengthened dichotomies and (ii) the visual analysis or how the changes of the physical structure of the housing estates have modified the relationships between the communal spaces. Maps of some housing estates are also included to exemplify significant phenomena.

3   MAIN FINDINGS

In general, Santiago de Chile exhibits a star-shaped pattern in which the most integrated places are the historic district and the thoroughfares that connects it with the periphery (Figure 3). With a relatively regular grid, the southern part of Santiago also has a high Global Integration. The wealthy northeast exhibits lower values due to irregular grids, gated communities and natural barriers that fragment (e.g., rivers) or enclose (e.g., mountains and hills) the territory. Outside the traditional city, Global Integration decreases as the distance from the city centre increases, reaching the lowest numbers in the recent suburban developments that have transformed the hinterland of Santiago. Likewise, Local Integration (r3) is high in the centre and around old rural towns that were absorbed by the growth of the city. On the contrary, Local Integration tends to be low in the recent suburban periphery due to residential developments that have limited connectivity.
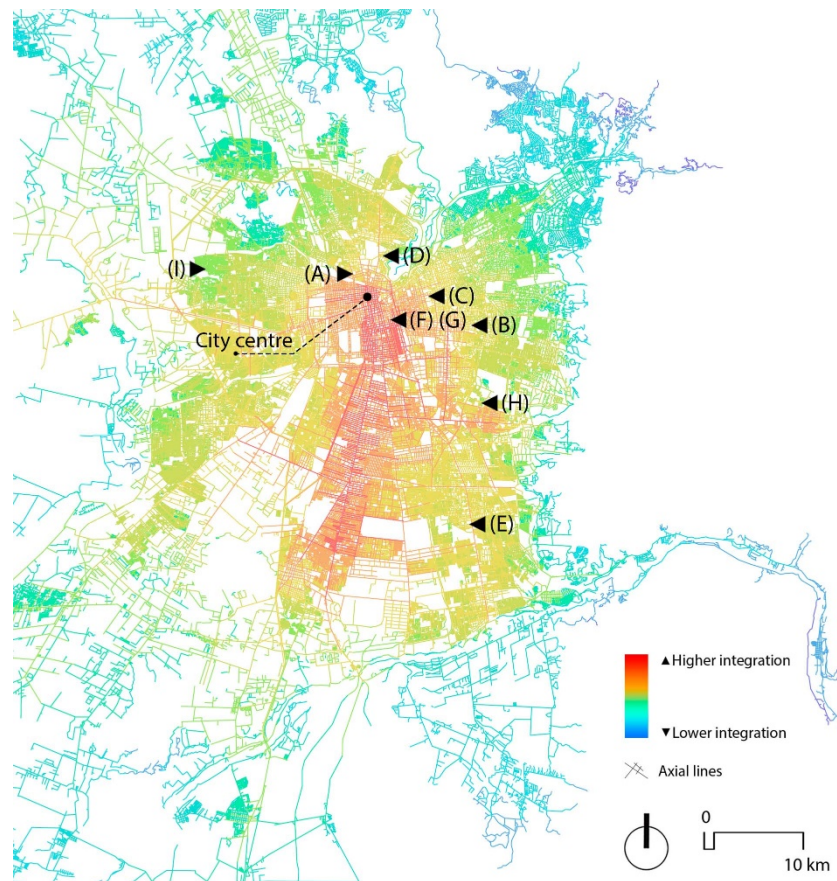
Figure 3: Global Integration of Santiago.

3.1 Axial analysis

The axial analysis shows that the nine housing estates have Global and Local integrations well above the average of Santiago (Figure 4). All of them are adjacent—or located nearby—highly integrated thoroughfares that connect the residential periphery with the centre. Furthermore, the data indicates that those housing estates located in the centre and east of Santiago (cases A, D, F, G) tend to be better integrated with the city and their surroundings. In fact, cases D, F and G have the highest integrations of the sample, being directly accessible from metropolitan avenues and surrounded by orthogonal and well-connected grids. The other housing estates have lower values, in particular, cases I and H that are, in addition, the most deprived of the sample.
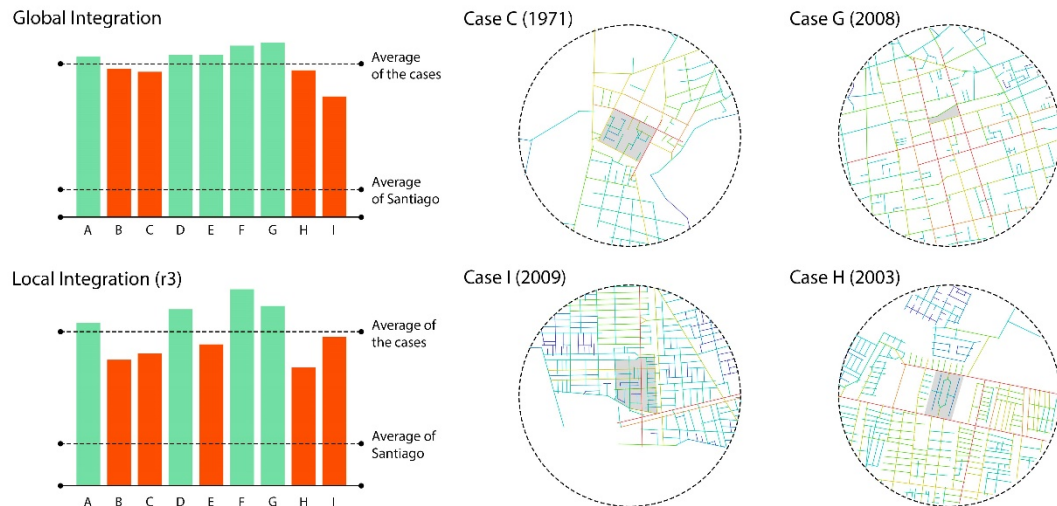
Figure 4: Global (HH) and Local (r3) integrations of the nine cases (green, above the average, and orange, below the average) and details of cases C, G, H and I.

Case I was recently built on the boundaries of the consolidated city (Figure 4). It is partially surrounded by rural land and has the lowest value for the Global Integration, showing how the well-known patterns of inequality affecting Santiago have worsened by the poor location of the social housing estates. Case H has the lowest Local Integration due to the few streets that connect the interior of the housing estate with adjacent neighbourhoods (Figure 4). As emerged during the interviews, this street layout, with few entrances, has strengthened the dichotomy between "us" and "them" and has increased the fear towards the outside.

Case C also exhibits a Global Integration below the average of the studied housing estates, despite being relatively close to the centre of Santiago and adjacent to a highly integrated thoroughfare. The integration of this case seems to be diminished by natural barriers (i.e., hills, river) and infrastructure (e.g., hospitals, cemeteries, markets) that have prevented the development of a continuous and connected grid to the north of the city (Figure 4). To a lesser degree, Case A is affected by similar issues. Its Global and Local integrations are high compared with the sample, yet low considering its closeness to the city centre. The river and the junction of two highways reduce the integration of the housing estate which is low if compared with the values of the other bank. As will be detailed in the next section, cases A and C have changed the most among the nine studied housing estates and, today, exhibit a high level of physical deterioration.

3.2   Visual analysis

The visual analysis shows that the inner structure of the housing estates located in areas suffering socio-economic decline (cases A and D) has been fragmented by numerous fences that trace clear limits between the private residential and the communal public space. The house fences (mostly opaque) have divided otherwise large community spaces and have created dark spots in the public space with low integration and poor visibility (case D, *see* Figure 5). The interviewees

from both cases indicated that their communities have changed to the worse. They asserted that they have not been able to build familiarity with their neighbours (who were often described as "strangers") and those they routinely encounter in the public and common spaces (who were characterised as "outsiders" or "wrongdoers"). They feel threatened by what may be happening outside and have built fences around their communal space in response. The analysis indicates, however, that fences have transformed the housing estates into a sequence of poorly integrated spaces. On the one hand, this has reduced natural surveillance and has increased the fear towards the outside (i.e., "no one will see me in case of an emergency"). On the other hand, it has fuelled the distrust towards the strangers who, from the residents' point of view, have no reason to wander and linger in spaces that connect "nothing with nothing".

Like Figure 5 shows, Case D also exhibits numerous irregular house and apartment enlargements that occupy former common spaces and further reduce the visual integration. Despite being relatively new, cases H and I also have apartment enlargements. This is a common issue of Chilean social housing estates; it originated in the extremely small units that some families received during the decades of 1980 and 1990 and still prevails among disadvantaged groups in spite of the current standards that are significantly better (Maturana, 2012; Olivares, 2018). The well-known consequences (reduced natural surveillance, increased fear of crime *see* Figueroa *et al.*, 2019) are visible in cases D, H and I where the integration of some spaces is decreasing due to the construction of the informal enlargements.
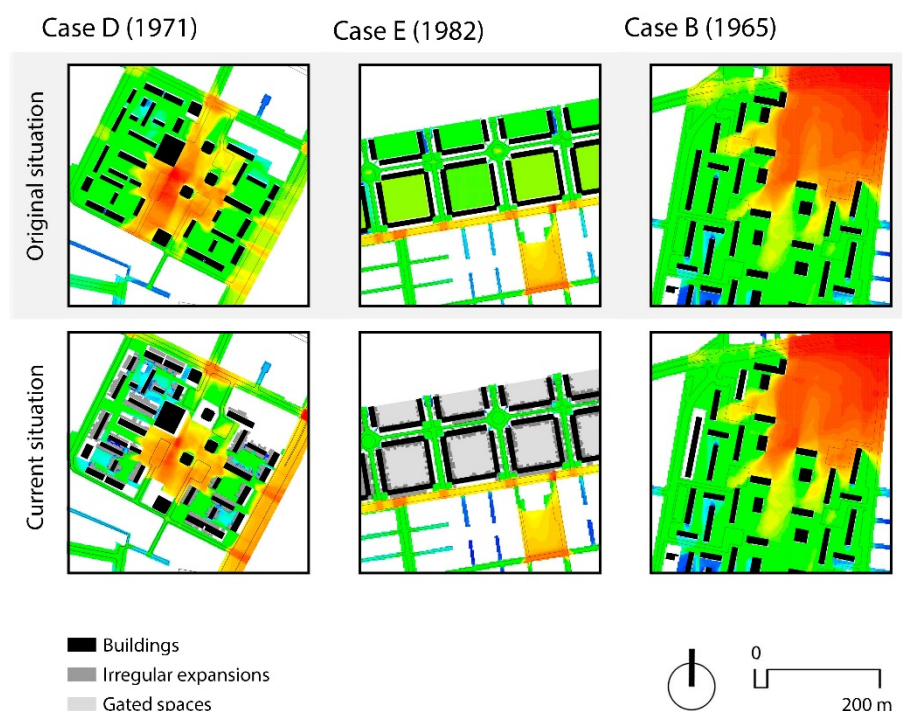

Figure 5: Visual analysis of selected cases.

Case H and I are also gated communities, following models that were traditionally restricted to wealthy suburban developments and are now widely seen by Chilean society as effective measures to counteract crime. Case E further illustrates this issue (Figure 5). This housing estate

was designed with highly controlled inner gardens (i.e., few entrances and visible from the houses) but is also gated. In contrast, the cases located in the wealthy areas of Santiago (cases B, C and F) show few changes regardless of the date of construction or the urban layout (*see* Case B in Figure 5). House enlargements and fences are mostly absent and, therefore, the relationship between the spaces has remained relatively intact. The interviewees indicated that they have discussed with their communities the possibility of closing the housing estate, yet unlike the cases located in declining or deprived areas, fear is not the driving force to do so. It is the desire to keep the good conditions in which their collective spaces are.

4   CONCLUSIONS

This article investigated the inner spatial structure of the housing estates and their integration with the rest of the city. It explored Santiago de Chile, a city that almost eradicated severe forms of deprivation—but that exhibits clear patterns of segregation and profound inequalities. The axial analysis of the nine cases shows that those located in deprived areas tend to have lower integrations due to urban layouts with few entrances or land that has yet to be developed. In contrast, the highest values were observed in housing estates located in wealthy areas. Furthermore, those cases located in central but declining areas tend to have low values due to infrastructures (e.g., highways) or natural barriers (e.g., rivers, hills).

The visual analysis shows that the public space of all the cases not located in the wealthy Santiago is suffering spatial fragmentation due to the construction of fences or irregular expansions that have grown over former public or communal land. Gates, fences and other forms of privatisation transformed relatively well-integrated spaces into labyrinthine structures with poor natural surveillance. The data gathered suggests that the privatisation of the space was a response to changes in the social architecture of the housing estates and has strengthened the dichotomy between the interior and the exterior, creating hostile spaces for residents and outsiders and fuelling the—already high—perception of insecurity of Santiago. On the contrary, the cases located in well-off territories have remained relatively open and have preserved their spatial structures over the years. The contrasting trajectory of the housing estates according to their socioeconomic background suggests that the existing schemes to "densify" underprivileged areas and ameliorate the inequalities from which Santiago suffers need to be redressed.

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