Spatial processes of mass housing estates.
Six case studies in Madrid

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Abstract. *Urban regeneration of deprived urban areas is one of the most important challenges of cities. This is recognised by International Urban Guidelines (ONU), as well as the Leipzig Charter and the Toledo Declaration (EU). Several studies have pointed out that mass housing states—the typical Modernist urban form—as one of the most deprived ones. Research has also indicated the physical, social, and economic problems associated to this urban form. Some authors have suggested that the original low spatial accessibility of housing estates within the city's street network could be one in part responsible to their early urban obsolescence. In Spain moreover, fifty years after the construction of most housing states, their initial accessibility conditions have changed. The research objective is triple. Firstly, to consider criteria to study the integration evolution. Secondly, to characterize the integration processes of mass housing estates. This allows a suitable evaluation of each specific case, adding nuances to generic visions. Lastly, to help to stakeholders to propose improvement strategies during urban regeneration processes. Using Space Syntax techniques, this paper shows the analysis of the original (1970s) and actual (2010s) spatial integration of six case studies in Madrid. Research methods also include data collection and definition of analysis scenarios adapted to Spanish datasets and interpretation of results.*

Keywords: Mass housing estates, integration, evolution, Space Syntax.

Introduction

One of the main goals in our cities is to enhance social cohesion, reduce social inequality and promote sustainable communities. Some authors have recognized urban regeneration as one of the most important tools to carry out this purpose (Couch et al., 2011). At this respect, some international institutions have recently shown greater interest in urban regeneration processes. In the last decade, they have produced some key documents as the International Urban Guidelines (UN-Habitat, 2015), the Leipzig Charter on sustainable cities and the Toledo Declaration (EU Ministers for Urban Development, 2007, 2010). All these documents highlight the importance to focus on deprived urban areas.

The typical Modernist urban form, called mass housing estates -henceforth just housing estates-, have been detected by several studies as one of the most vulnerable morphologies (Hernández Aja et al., 2015; Wassenberg et al., 2004). This vulnerability, discussed by several authors from different perspectives -from cultural to technical approaches-, is usually generic for all housing estates (Monclús and Díez Medina, 2016b). However, fifty years after its construction, this idealistic urban form shows more divergences in the current situation of housing estates (Wassenberg et al., 2004, 4). In this regard, it is relevant to study the specificities of different housing estates, focusing on a comparative and

evolutive perspective. Hence, one of the main objectives of the Ur-Hesp[1] project is to develop a systematic analysis of urban obsolesce processes of functionalist urbanism morphology. Additionally, these systematic analyses could help to improve decision-making processes during urban regeneration of housing estates.

In this way, it is not easy to attend all issues that this morphology concentrate, because of the systemic nature of problems, where physical, social, and economic dimension are strongly related. However, our study is based on a basic assumption: the role of design in these housing estates is relevant, and, in part responsible of their issues. Hence, urban design could facilitate partway improvements in deprived housing estates (Urban Task Force, 1999; Wassenberg, 2013). At this level, the spatial integration of housing estates within the city's street network must be considered. According to this idea: the more integrated an urban area is, the better support to urban life could be (Hillier, 2007, 169).

For that, according to the greatest divergence detected fifty years after housing estates construction, it is interesting to recognize their urban obsolescence as a process. The growth of cities has modified the initial accessibility conditions. Therefore, it is relevant to evaluate their evolution. Previously, researchers have found on space syntax theories a useful tool to better understand the accessibility evolution of an urban area (Arnaiz Hernández et al., 2013; Pinho and Oliveira, 2009; Zumelzu Scheel et al., 2016). Similarly, this study also uses space syntax methods to analyse these spatial processes.

The aim of this study is triple. Firstly, to study criteria to apply space syntax methodology to the spatial integration evolution study. Particularly, our criteria focus on specific characteristic of housing estates, adapted to Spanish datasets, according to the six case studies located on Madrid. Secondly, to characterise the integration processes of mass housing estates. This allows a suitable evaluation of each specific case, adding nuances to generic visions. Lastly, to help to stakeholders to propose improvement strategies during urban regeneration processes.

Methods

Two different analysis have been carried out. The first one is the characterisation of housing estates and their improvement processes performed. At this level, significant literature has been reviewed, developing both an initial and an evolutive categorisation of housing estates characteristics and performances, from a spatial approach. The second one measure spatial integration processes, using space syntax methodology. To establish some conclusions both partially results will be finally compared together.

More in detail, space syntax theory and methodology -described by several authors-, is based on the relationship of spaces flowing in-between blocks, providing a representation of spatial relationships with syntactic measures (Al_Sayed et al., 2014, 7). International scientific community have contributed over the years to improve methods and specialized software. Currently, there is debate focused on axial lines because both the objectivity of drawing process and the consumption of large time and effort, should be improved (Dhanani et al., 2012). At this sense, some authors focus their researches on use of axial lines computer-aided drawings. Others have discussed about the use of centre road lines. Even more, Dhanani et al. (2012) have recently studied the use of open data as Open Street Maps (OSM) in space syntax analysis. They point out two main advantages: the objectivity and the optimisation of time and effort. However, the study concludes with two important advices: firstly, it is important to evaluate the reliability of the cartography before use OSM data. Secondly, there is not clear the influence of pedestrian paths and movements using OSM data. Hence, taking into account these recommendations, our methodology is based on these researches. Next paragraphs describe in detail considerations on data collection, scenario develop, calculation and post-processing, aiming to give an exhaustive description of space syntax methods.

The data collection starts obtaining road centre lines from Open Street Maps (Geofabrik GmbH and OpenStreetMap Contributors, n.d.), an open and updatable database. Considering

Dhanani instructions (2012) and in regard to our case study, Open Street Map data is one of the most reliable data source. At this sense, national cartography programs complete and update OSM platform. Then, data is download in shapefiles ready to use in advanced cartography tools as Geographic Information System (GIS).

The next step is to develop two models, one of each temporal scenario. OSM data are ready to use as current scenario, once pedestrian routes have been excluded from the model, (Dhanani et al., 2012). However, initial scenario must be drawing using historical cartography. We have selected 1975 as initial scenario because, first, most housing estates had been built. Second, because since then they have passed more than forty years. Last, because National Geographic Institute (Instituto Geográfico Nacional, n.d.) developed two useful cartographies during this year. The first one, represents Madrid province (1:200.000), and the second one, represents Madrid city (1:25.000). Considering both it is possible to draw Madrid metropolitan area during 1975.

The calculation process was carried out using QGis Space Syntax Toolkit v0.1.6. We have considered angular segment analysis, and we have cleared stubs up to 40%. The integration measure is calculated considering both radio n and radio 800 m, to obtain global and local measures. When considering 800 meters, we take into account a proximity integration of ten minutes walking. Finally, we have obtained
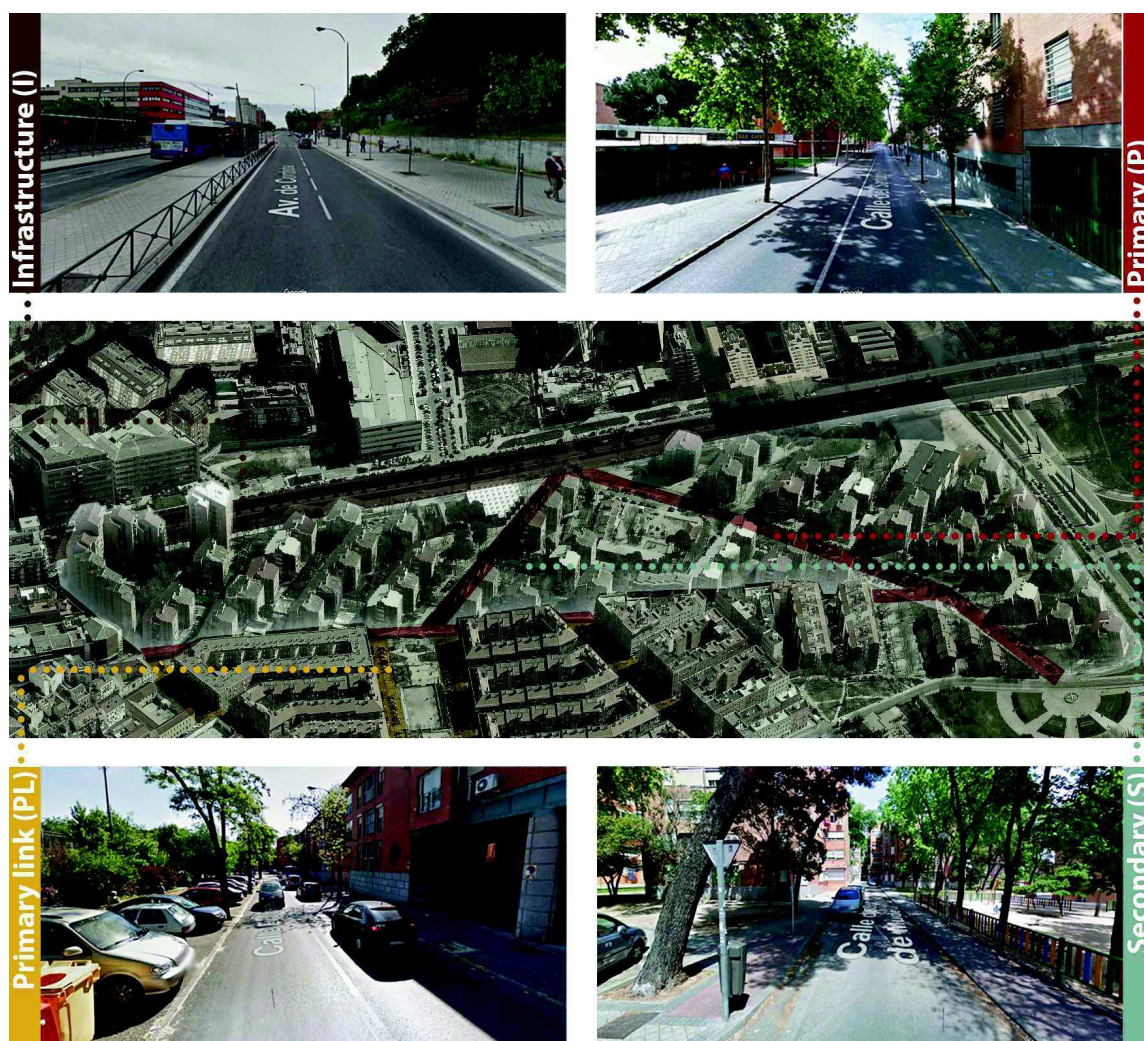

Figure 1.
Types of streets considered

normalised integration measures, enabling the comparison between both scenarios (Al_Sayed et al., 2014, 78).

As a consequence of housing estates present diversity of street types, four street categories must be considered during post-processing (Figure 1):

-Infrastructure (I) are the main access of many housing estates. They are motorways or great avenues, with a particular non-pedestrian character. The develop of estates, considered as self-sufficient urban areas, depends on the relation between these infrastructures and the whole of the city, especially on a global scale.

-Primary link (PL) are responsible of the connectivity of housing estates with their close urban fabric. The more isolated a housing estates is, the less primary links in its perimeter it has.

-Primary street (P), which constitute the main streets that give structure to the urban area. Many of these streets describe superblocks.

-Secondary street (S) depends highly on the primary streets, and in many cases, they are cul-de-sac. Nowadays many of these streets have lost their pedestrian character to give more capacity to parking areas.

Case studies: six Madrid mass housing estates

Like many other European countries, during the mid-twentieth century Spain faced the urgent need of housing with the construction of mass housing estates or 'polígonos de vivienda' (Turkington et al., 2004). This study focus on the housing estates built in Madrid, considered a laboratory of these urban form and studied by López Lucio et al. (2004). We focus on the period between the 1950s and 1970s. This is the period of maximum constructive activity and shows a change in the trend from quality to quantity (Monclús et al., 2016b). At this sense, it is possible to distinguish two housing estates generations: the first one, corresponding to the decades after the Spanish civil war (1940-50s), is more experimental and presents a greater concern for quality. The second one (1960-70s), influenced by economies of scale, premiums quantity versus quality (Monclús and Díez

Medina, 2016a). This is when housing estates become the standard urban form in new urban developments.

According to this consideration, we have selected six housing estates, three of each generation, obtaining a sample of various design solutions (Figure 2). From the first generation, we have selected three housing estates recognized by Do.co.mo.mo by its architectural quality (AA.VV., 2009). Moreover, all of them being about 20 ha. and less than 20.000 dwellings and from the urban point of view, they present some design differences:

A - Fuencarral (1957), located on the north of Madrid. This housing estate is linked since its origin to road and railway infrastructures at the west and the south. It presents a ring of main circulation on which they support secondary streets.

B - Virgen de Loyola (1958), located on the south of Madrid, presents a superblock structure. Inside, the original ring of pedestrian character has been transformed to improve the parking standard deficit.

C - Almendrales (1959) also depends on another important infrastructure to the east. Since its origins it is more connected with close urban network than others housing estates. Inside, it is organized through two diagonal streets, which divide the area in three superblocks.

Second housing estates generation presents bigger promotions (more than 4.000 dwellings and no less than 30 ha), generally with higher densities:

D - Gran San Blas (1959) is located on the natural extension of Arturo Soria (C/ Hnos Gª Noblejas), structured through six superblocks (or plots). During 1979/81 one of these superblocks was redevelop, modifying drastically its urban morphology.

E - San Cristóbal de los Ángeles (1959/64), is located on the south and depends on Avenida de Andalucía highway. In addition, the rail infrastructure creates a barrier both to the north and the east. As consequence, still it shows an enclave character.

F - Barrio del Pilar (1960/72/75) is a private development. Since its origin, it presents more autonomy. This enclave character has now
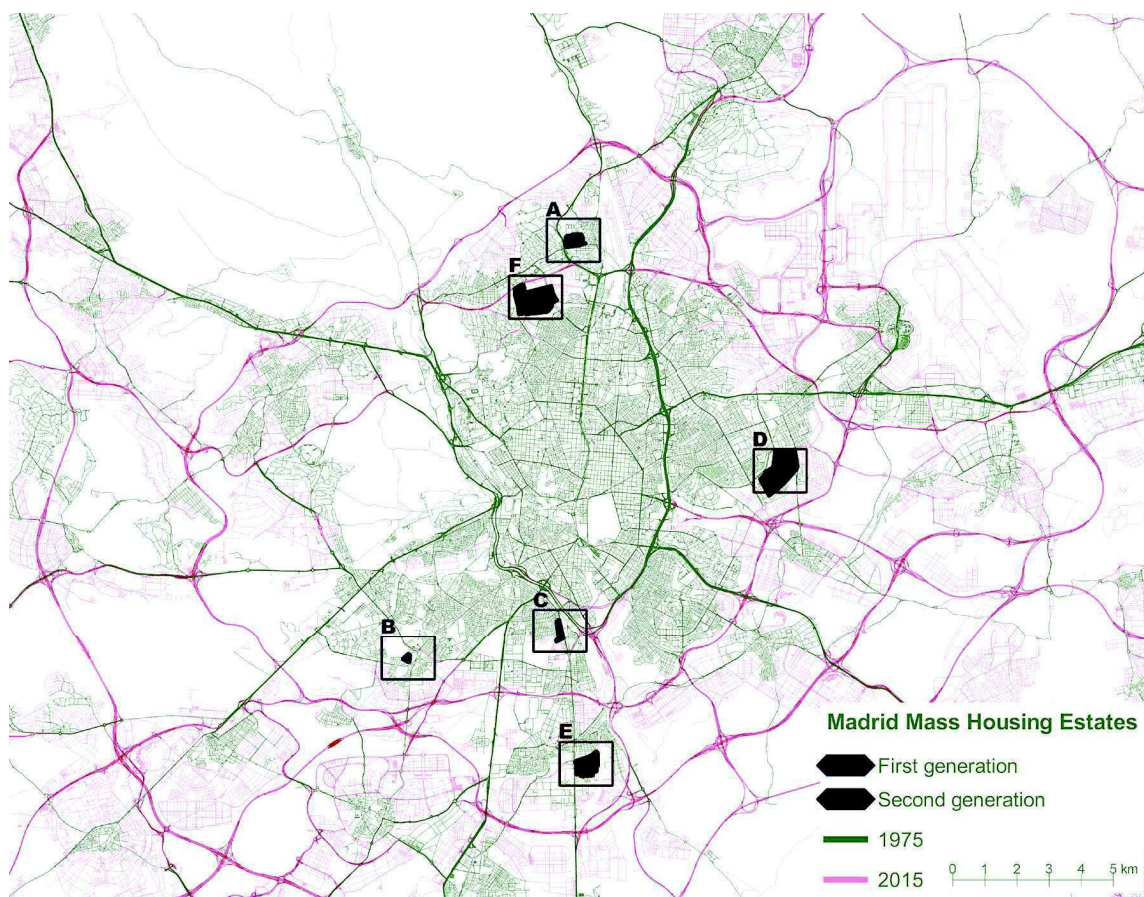
Figure 2.
Urban location of housing estates in Madrid (1975-2015)

been corrected, both for the construction of the M-30 highway, and for the growth of the close urban fabric.

Improvement characterisation

During the analysed period, there have been significant changes in the study cases. At this sense, it is important to point out that improvements are not presented univocally in a housing estate. However, it is possible to classify and summarize them from global to local improvements (Figure 3):

  -Improvements by the creation of new infrastructures not directly related: when the new infrastructures do not directly support the housing estate, but help to improve its spatial integration (Loyola, Gran San Blas).

  -Improvements by the creation of new infrastructures directly related: where new infrastructures support the housing estates.

Its development help to improve the relative position of these urban areas (Barrio del Pilar, San Cristóbal).

  -Improvements by the growth of cities in the perimeter of the housing estate: when a greater integration level has been developed by stitching operations -planned or unplanned- between housing estate and its close urban fabric (Gran San Blas, Barrio del Pilar).

  -Local significant variations, when the internal structure has been modified as a result of redevelopment operations (Gran San Blas).

  -If they no present significant variations (Fuencarral).

Spatial processes: results and discussion

The analysis includes two integration measures: global and local. The first one measures the spatial integration level of an area with respect

Figure 3.
Housing estates improvement characterisation.
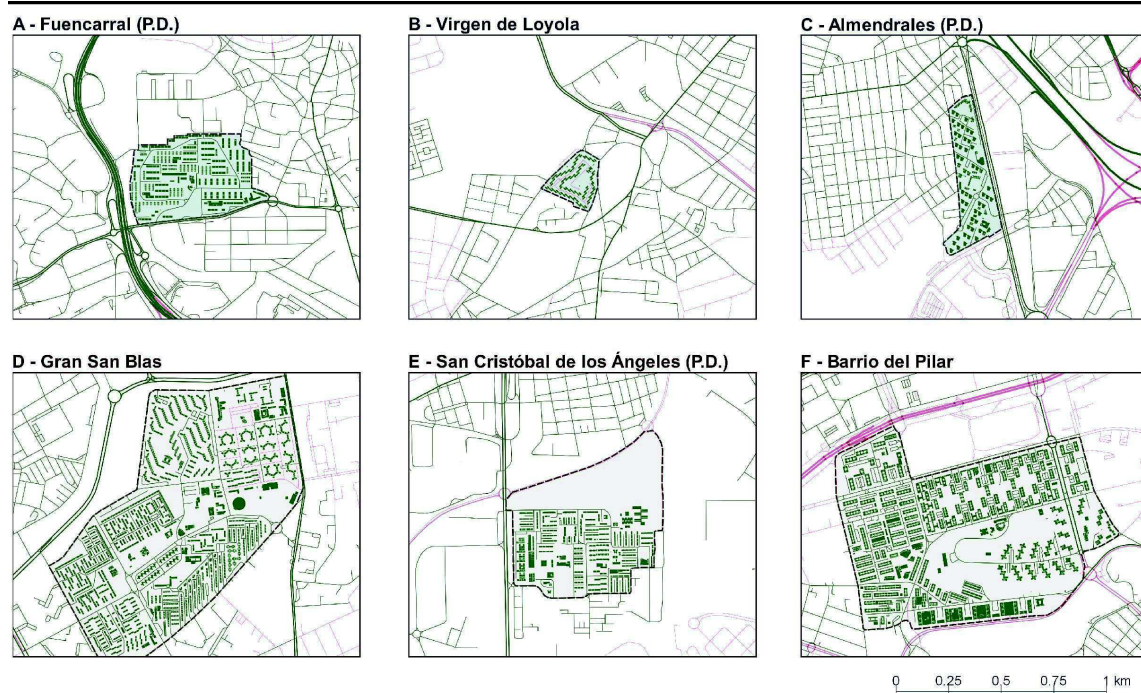
		From global to local improvements				
		Indirect new infrastructures	Direct new infrastructures	City growth in the perimeter	Local significant variations	No significant variations
A	Fuencarral					●
B	Loyola	●				
C	Almendrales		●			
D	Gran San Blas	●			●	●
E	San Cristobal		●			
F	Barrio del Pilar		●		●	

to the whole city. The second one measures the spatial integration level of an area with respect of its walkable area, considering ten minutes walking -800 meters- as calculation measure.

Global Integration

Considering global integration, it is important to attend to streets categorised as infrastructures (I). The main objective of these streets is to connect housing estates with the whole city. Figure 4 and 6 show global spatial integration measures in 1975 and 2015 scenario. It is true that attending to 1975 scenario housing estates present a peripheral location, as many authors have pointed. However, during the studied period, the evolution is not as homogenous as some authors consider. More in detail it is

possible point out three different evolutive patterns, always considering that the whole city has increased its spatial integration level. The first one includes housing estates which integration level increase well above the average. This is San Cristóbal and Virgen de Loyola case, influenced by the improvement works carry out in the south of Madrid. The second one represents housing estates which integration level increase above the average, such as Almendrales and Gran San Blas. The last one represents housing estates which integration increase in the average, such as Fuencarral. This happen because whereas the spatial integration increase in the whole city, no significant improvements has been developed in this housing estate.
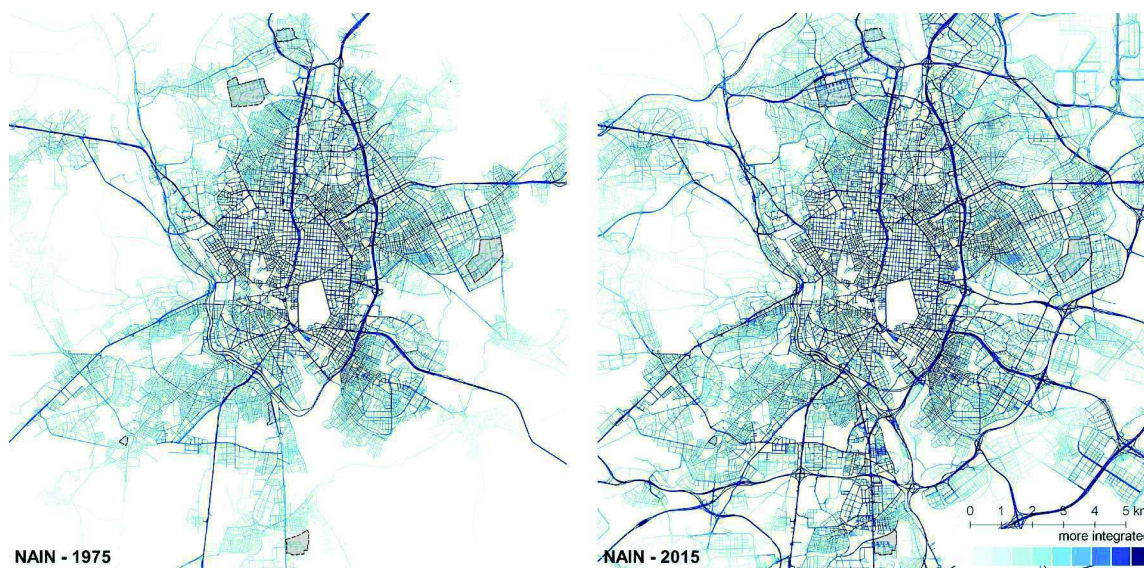
Figure 4.
Global integration map (1975-2015).

Figure 5.
Local integration map (1975-2015).

Local Integration

Taking into account local integration, it is important to considered primary and secondary streets, as well as primary links by their local character (Figure 5 and 6). These streets are more responsible in the develop of urban life, compared with previous streets. City average values show a downward trend, caused by the appearance of more spatial integrated local areas, with a lower absolute data.

Firstly, if primary links are considered, local integration shows the relationship between the housing estates and its close environment. At this regard, results show four different situations: in the first one, housing estates present a good initial integration into the urban fabric, and their results improve during the analysed period. This is the case of San Blas and Barrio del Pilar, where new urban fabrics have been built supporting initial housing estates, improving their integration. In the second one, there is a good initial integration, which has barely improved at present. This

situation is present in Loyola and Almendrales, where their close urban fabric does not show significant improvements. The third one represents housing estates with an initial mean value, without variations in the studied period. This is the case of Fuencarral, where their close urban fabric is not as well integrated as the other ones, and without significant variations during this period. By last, some autonomous housing estates never had primary links, and during this years, there is not improvements at this level. San Cristóbal case study represent this configuration. As consequence, currently this housing estate shows a large isolation level, because close urban fabric has never been developed.

Secondly, we attend to primary streets, which values show how superblocks work into the urban network. At this level, two different processes have been detected. The

first one, where primary streets form a network well-connected with close urban fabric, both since its origin or through improvement performances. In this case the integration level processes are better, as Barrio del Pilar, Gran San Blas and Loyola verify. Currently, all of them present local integration levels above average value. An exception is Almendrales, which present similar characteristic. However, its proximity to a local well-integrated area reduces its values. The second one includes housing estates which primary streets are not connected with its close urban network. As there has not been improvement performances, these housing estates have not experienced integration processes. San Cristóbal and Fuencarral confirm this situation, where their superblocks have a relatively lower level of integration.

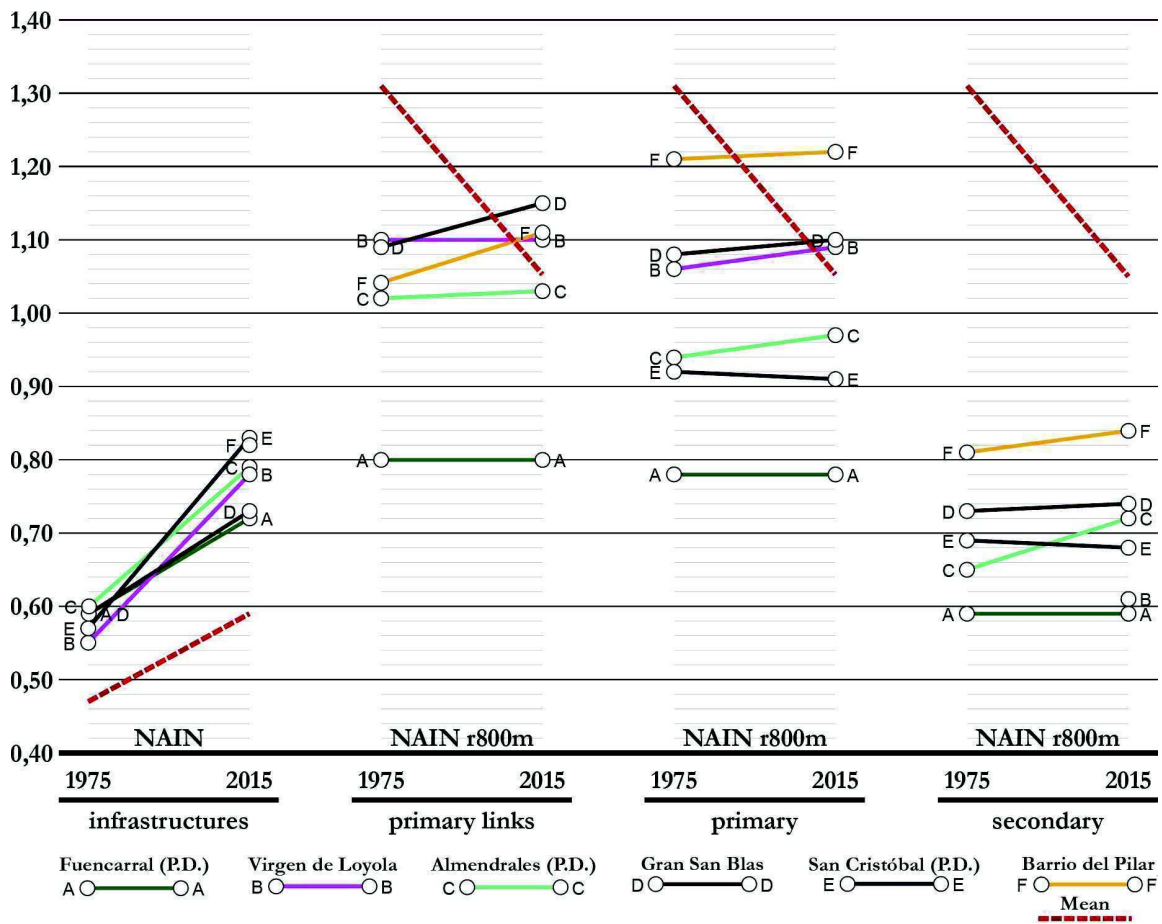Lastly, we consider secondary streets. First

Figure 6.
Integration process results.

of all, it is important to highlight than any of these streets reach average values. The morphological characteristics of these streets -usually cul-de-sac- is responsible for not developing high integration levels. Moreover, their values depend largely on primary links values and their evolution. As internal structure of housing estates has rarely modified, it is expected not found significant variations. However, Barrio del Pilar and Almendrales, whose cul-de-sac number are lower, are the exception rather than the rule. Also, San Blas differs because in this case, some improvements have been made in a specific superblock. However, these enhancements do not represent major differences at this level.

Interpreting results

This section establishes a relationship between improvement categorisation and spatial integration measures. Firstly, taking into account the initial classification as first and second generation housing estates and based on the results obtained, there does not seem to be a direct relationship. The first -where quality prevailed- are not necessarily better integrated. However, this does not mean that the classification used is not effective, because urban quality depends on many other factors, such as accurate density, compactness, mixed uses, open spaces system, ground floor configurations, among others, and all together must be considered.

Apart from that, there seems to be a link between improvement performances and integration evolution. In this regard, the more improvements a housing estate has achieved, the more successful spatial integration process results. Barrio del Pilar verifies this idea, which improves both its global and local integration measures. The reason is the direct influence of the construction of new infrastructures and the growth and stitching of its internal structure with new urban fabrics. Similar results, considering specific particularities for each housing estate, highlight Virgen de Loyola, Gran San Blas or Almendrales. At the far end, we find the least intervened housing estates. In Fuencarral case study, non-intervention during studies period has meant that its global and local results have not changed in relative terms. In San Cristóbal, it is true that efforts made during new infrastructures construction have influenced better global results. The problem is that local integration has never been improved. In any case, these preliminary results must be confirmed in future steps by including a large sample of case studies.

In the light of the results obtained, the specific analysis of each case becomes useful to identify possible improvement strategies. For instance, these analysis of six case studies has identified the need to implement improvements primarily on local integration. In particular, Fuencarral and San Cristobal housing estates are the most disadvantaged. In them it is necessary to devise strategies that allow improvement especially the accessibility of their urban fabric to the close urban network. These improvements could alleviate the barrier effects of its infrastructures, mitigating its enclave character. As in the example, once considered the particularities of each case, it would be possible to establish individualized improvement strategies. Hence, it seems clear that the study of the integration processes attending specifically to each housing estate is relevant in order to help to stakeholders during urban regeneration processes.

Conclusion

The text has characterised spatial integration processes in mass housing estates. Against some generic visions which indicate poor spatial integration, the study has verified the existence of high divergence between cases, from an evolutive framework. Therefore, in view of the greater diversity of situations, the systematic analysis of housing estates is useful in order to add nuances to generic visions.

For its realization, the methodology carries out on the one hand, the improvement processes characterisation performed in each housing estate. On the other, the spatial integration level is calculated using space syntax technique. The methodology used considers recent scientific contributions, which improves both more objectivity during the drawing process and optimisation of time and effort consumption.

Results show firstly how city's growth has positively influenced the improvement of spatial integration level of the analysed housing estates. However, those in which more direct or indirect interventions have been carried out -such as new access infrastructures construction, stitching operations between new and existing urban fabrics, etc.- manifest better spatial integration levels. The categorisation of housing estates on first and second generation does not appear relevant, at least a priori, in the characterisation of the level of spatial integration, although it can be useful in many other urban characteristics.

Moreover, this methodology allows to observe in detail each housing estates. It is useful not only to know and characterise better the processes happened, but also as a tool that could help to stakeholders during decision making in urban regeneration processes.

Lastly, during this exploration, we have detected possible research lines. First, future research steps should extend this proposed methodology to other housing estates. Currently our research project works with a significant study case of thirty-two housing estates, located in Madrid, Barcelona, and Zaragoza (Spain). Second, spatial integration level should be combined with other variables such as density, land uses, vulnerability, etc. -more objective-, or open spaces character, public space social activities, etc. -more subjective-, to better understand urban obsolescence processes of housing estates and promote their urban regeneration.

Acknowledgment

Notes

1 Ur-Hesp (New challenges for Spanish Cities: the legacy of Modern Housing Projects and options for their Urban Regeneration. Similarities and differences with Western and Post-socialists European models). More info: http://pupc.unizar.es/urhesp/

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