Dealing with mass housing estates legacy: The need of specific diagnoses from an urban design perspective

Carmen Díez Medina, Javier Monclús
Escuela de Ingeniería y Arquitectura. Universidad de Zaragoza. Zaragoza, Spain
E-mail: cdiezme@unizar.es, jmonclus@unizar.es

Abstract. *In the recent international debate about mass housing estates built during the decades of rapid urban growth after World War II, different approaches coexist. It has only been in the last years, that urban planning and urban design perspectives have been considered in depth. In the case of Spain, some global and local visions complement more specific approaches, such as the ones focused on the obsolescence of dwelling typologies and urban forms. Our starting point is that Spanish collective housing estates (polígonos) constitute a huge legacy which needs accurate diagnosis. Our research has been developed from an urban design perspective, focusing on urban forms and open spaces. The goal is to add some nuances to certain excessively generic interpretations, trying to find indicators, some of them measurable and other empiric, that allow a suitable evaluation of each specific case, beyond too subjective approaches. In this way, systematic diagnosis could provide more appropriate knowledge for the urban regeneration, recovery or reactivation of these estates. This paper addresses with a European comparative perspective some case studies of Spanish housing estates (polígonos) built in Madrid, Barcelona and Zaragoza between 1950 and the 1970s. The quality of the urban projects and the obsolescence or resilience processes has been tested by contrasting the original situation at the time of their construction with their current state.*

Keywords: Collective housing, mass housing estates, modernist urban forms, modular housing blocks, high rise apartments, polígonos de vivienda, urban design.

Introduction. Mass housing estates and modernist urban forms

In the recent international debate about mass housing estates built during the decades of rapid urban growth after World War II (1950s-70s) different approaches coexist. Some of them focus, from an architectural and historical perspective, either on the 'best examples' (AA. VV., 2009) or on the problems which resulted from the adoption of the CIAM and the Athens's Charter principles (Hall, 2014, 19). It has only been in the last years, that urban planning and urban design perspectives have been considered more in depth (Urban, 2012; Wassenberg, 2013).

What do we mean when we speak about collective housing, mass housing estates, modernist housing estates, modular housing blocks or high-rise apartments? As there are many possible interpretations, it is necessary to define well the subject of study. We understand housing estates as sets of dwellings associated with social housing as well as for middle-class. Therefore, we are considering social housing and even other private residential developments (Grupo ADUAR, 2000). Possibly in France is where the new urban form of collective housing schemes is better understood: "rather than a form of housing construction, the term 'grands ensembles' designates a form and a landscape characterized by the grouping of blocks and towers on a space subject to the rules of zoning" (Dufaux and Fourcaut, 2004,

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45). This is a form of urban growth which, with the high-rise housing boom of the period, broke with the continuous extension patterns of the European city, both in the North and in the South, in the West and in the East (Monclús and Díez Medina, 2016).

The evaluation of the experience and legacy of European mass housing estates built in that period has drawn different interpretations. On the one hand, it has been recognized as a successful response to the huge housing crisis and demand after World War II. In addition, the logic of the market, the industrialization and the technocratic management were also important factors. So that the success of the Athens Charter could be seen a consequence of the dynamics of the building sector and the enthusiasm of technocrats, engineers, economists, developers… and, of course, architects. Moreover, rather than the Charter, we should realize that all this new spirit was very present at the time. It was the imposition of the 'hard modernity' options and the rejection of the existing city as something 'disorderly' or 'obsolete', which led to include the ideology of the Charter in the official planning documents after the War (Díez Medina and Monclús, 2017, 68–69).

On the other hand, the review of this legacy fifty years later leads to speaking about failure to a certain extent: obsolescence of typologies, urban spaces and building technologies, as well as loss of environmental quality (García Vázquez et al., 2016). The general view is that the modernist design and modernist urban types that were on the basis of most of the projects were responsible for that failure. However, the results were not so homogeneous. The fact is that diversity of housing estates in different countries and cities – and even within a single city, namely the value of the specific aspects of each case, deserves a more precise approach.

Spanish housing states in the European context

The phenomenon of the mass housing developments built in Europe during the period considered here has been analyzed by the history of urbanism with different interpretations. Generally, the urban quality of some notable[1] examples is recognized, as well as the 'failure' of other cases more or less emblematic[2], both designed by prestigious architects. The Spanish case is not so different in terms of the contrast between the results of different experiences. Despite some quality examples have not aged poorly[3], many other cases[4] experience important problems of various kinds.

The nature and role of CIAM urbanism has also been the subject of a large number of studies and interpretations (Gold, 2007; Mumford, 2000). In Spain, as in other European countries, critical visions of CIAM's functional urbanism appear since the 1960s, as opposed to other claims from the movement of the Modern Movement (Do.co.mo.mo), which have highlighted the values of certain collective housing projects[5]. At this point, some questions arise: Are the Spanish housing estates (polígonos) a typical example of the urban forms associated with the "high-rise housing boom" of the 1960s and 1970s that spread throughout Europe? Why have some housing estates experienced processes of urban obsolescence while others are relatively successful? What has been the role of urban design in their operation, from the initial options associated with urban planning projects and plans that define the arrangement of the sets?

From an urban and morphological perspective, some studies allow us to value important parallels with the experiences of the rest of Europe (de Terán, 1978; Monclús and Díez Medina, 2017). For example, in the generalized step 'from the urban block to the building block' (Panerai et al., 1986), which occurred after a few transition and experimentation years during the postwar period. Spanish polígonos also have the character of autonomous, 'concentrated' pieces, that is to say, they are units built in unity, in the face of the gradual growth of residential extensions that dominated in Spanish and European cities until the middle of the 20th century[6].

With the broad perspective of the intense international debate, enriched with numerous contributions at the local level, it is interesting to consider the impact that the principles of modern urbanism had on the reality of the construction of Spanish collective housing

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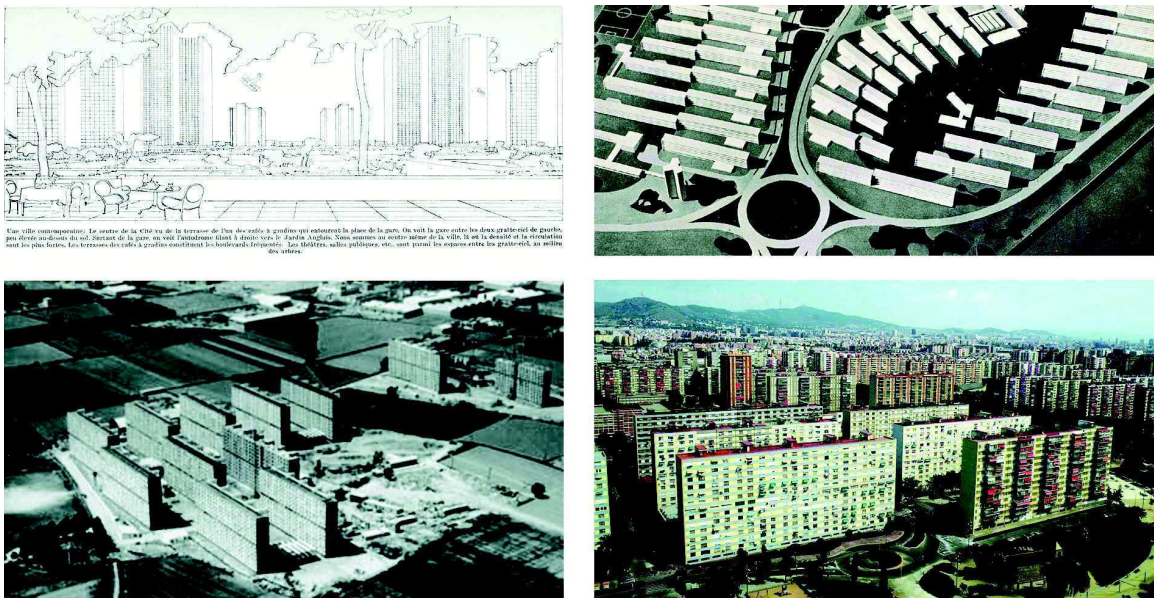

Figure 1.
'Theorised' urbanism versus 'real urbanism': Ville Contemporaine, Le Corbusier (1922); Bellvitge (Barcelona): original project (model), the housing estate under construction and today.

in the decades of great urban growth after the 1950s. As a starting point, among the numerous critical assessments of the functionalist urbanism of the CIAM and the Athens Charter, we can pick up the synthesis of Ramón López Lucio when he points out a series of principles - explicit or implicit - "that have configured a good part of the periphery in European and Spanish cities"[7]. We intend to check to what extent the problems are common or how can be fine-tuned in the diagnosis. The objective of our study is to qualify the generalized criticisms, trying to overcome the topics and making a more accurate assessment according to the specific situation of each polígono studied, since the variety of cases and situations demands it.

Urban design and urban quality in Spanish housing estates (polígonos). Some diagnoses from a morphological perspective

Keeping in mind the differences in scale of the three cities considered (Madrid, Barcelona, Zaragoza), representative of what happened in other Spanish cities, it is necessary to take into account what was the accelerated urban growth in Spain between the years 1950 and 1975, with annual rates higher than 3% in the 1960s (Guardia et al., 1994, 13). The selection that has been made to analyze the Spanish case - 32 polígonos located in these three cities - aims to be representative of the reality of urbanism built in front of other selections based on the outstanding architectural quality of the sets, such as those of Do.co.mo.mo.

Based on the analysis of the 32 specific cases of Spanish polígonos we have selected in our research[8], we here discuss 10 commonly accepted principles as critical aspects of modernist housing estates, questioning the relevance/usefulness of generalized criticism.

01 Size. Is size decisive for urban quality?

It should be noted that the size of the housing estates increased during the period under consideration, going from the promotions of a few hundred homes in the 1950s to several thousand in many of those built in the 1960s and 1970s. The urbanistic criteria regarding size were linked to the growing demand and the viability of the promotions.

In the sample analyzed we can verify this oscillation[9] (Figure 5). Although there is a tendency to identify the larger ones with the ones that present the most problems, due to the acceleration in the construction processes and the standardization of solutions generally associated with mass growth, this is not always the case. Can we therefore say that size is a

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Figure 2.
Figure-ground plans of the 32 housing estates analysed. Graphic documentation elaborated by Sergio García within the framework of the project UR-Hesp. © Authors

condition associated with poor urban quality of the poligonos? Not necessarily. Bellvitge, for example, has a much larger size (9,780 homes) than the Ciudad Meridiana (4,000 homes), and its urban quality is not inferior but the contrary.

The size, in relation to the urban quality of the poligonos, is a parameter that is directly linked to other aspects, such as the variety of urban forms, the road system or integration in the existing urban fabric. Therefore, to consider it decisive at the time of determining the urban quality of a whole would be, at least, generalist.

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			Construction year	dwellings (dw)	hectareas (ha)	dw/ha	Floor Area Ratio (F.A.R.)	Coverage	Height Index
Madrid	PU	Entrevías	1957/1966	8.395	83,3	101	0,91	27%	3,4
	PU	Virgen de Begoña (PA)	-1959	1528	13,6	112	1,19	24%	5,1
	PU	Caño Roto (PD)	1959-63/68	1.907	20,0	95	0,82	28%	2,8
	PU	Fuencarral (PD)	-1960	1.839	21,0	88	0,86	26%	3,3
	PU	San Vicente de Paúl	1961	2.034	14,6	140	1,09	30%	3,6
	PU	Virgen de Loyola	1962	762	4,7	162	1,01	24%	4,2
	PU	Gran San Blas	1962/70	10.442	95,0	110	0,87	20%	4,3
	PU	San Cristobal de los Angeles	-1962/65	4.175	31,4	133	0,85	14%	4,5
	PR	Estrella	1963	6.094	33,5	182	2,09	26%	8,1
	PU	Almendrales (PD)	-1966/73	1.437	11,6	124	1,02	23%	4,6
	PU	Grupo Juan XXI	1966	502	3,2	157	1,40	31%	4,7
	PR	Saconia	1967/79	2.900	28,0	104	1,40	23%	6,1
	PR	Barrio del Pilar	1968/75/78	19.641	92,0	213	1,81	23%	7,7
	PR	Parque de las avenidas	1969	4.536	33,3	136	2,00	25%	7,7
	PU	Moratalaz	1969/73	9.424	126,9	74	0,80	16%	5,1
	PU	Cuartel de Montaña	1970	2.328	18,9	123	1,16	24%	4,7
Barcelona	PU	Trinidad	1953-55/57-	3.095	25,5	121	0,92	20%	4,6
	PU	Sudoeste del Besós	1959-61	4.843	34,5	140	1,15	24%	5,0
	PU	Montbau	1960-65	2.296	19,2	120	1,03	19%	5,2
	PR	Sant Ildefons	1960-	11.536	45,3	255	1,71	24%	7,0
	PU	La Guineueta	1962-63	2.500	22,7	110	1,03	19%	5,5
	PU	Sant Roc	1962-	6.634	46,2	144	1,13	20%	5,7
	PR	Ciudad Meridiana	1964-	4.000	37,3	107	0,80	15%	5,2
	PU	La Paz	1965-	2.499	16,0	156	1,68	20%	8,1
	PR	Bellvitge	1968-	9.780	65,4	149	1,38	18%	7,7
	PU	La Mina	1971-	2.644	17,1	155	1,56	19%	7,0
	PU	Ciudad Badia	1972-	5.372	64,0	84	0,82	15%	5,6
	PU	Canyelles	1973-	2.651	23,6	112	1,38	18%	7,8
Zaragoza	PR	Salduba	1958	230	1,0	232	1,35	27%	5,0
	PU	Alférez Rojas	1961	656	5,1	129	1,02	22%	3,9
	PR	Polígono Romareda	1961	2224	29,0	77	1,11	23%	5,5
	PU	Balsas de Ebro Viejo	1964/75	1.534	12,6	126	1,12	25%	4,2

PU Public
PR Private

Figure 3.
Data table of the 32 polígonos analysed in Madrid, Barcelona and Zaragoza. © Authors.

02 Density. Does density matter?

There is no unitary criterion that relates the densities and edificabilities of the polígonos to their urban quality (Ezquiaga, 2015). In the sample analyzed we can see significant differences between densities below 100 dwellings/ha (considered low for housing estates, but that would be 'average' or even high for traditional city standards), those ranging between 100 and 130 (medias) and those higher than 130 (high)[10] (Figure 5).

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The interesting fact for our argument is that in the three cities analyzed the average densities of the polígonos are not higher than those of the urban plots that are configured according to more conventional principles in other neighborhoods that were growing gradually in those same peripheries during that period. On the other hand, due to a series of circumstances, the density of the Spanish polígonos is higher than that of other Europeans[11], which offers more possibilities of increasing urban intensity and increasing diversity (Ferrer i Aixalá, 1996). The possible problems, either of overcrowding or of urban vitality, of the Spanish polígonos can not be attributed to their density, as is usually done, by not properly linking this information to the urban forms of blocks and towers in height.

03 Coverage. Is modernist estates coverage that low?

One of the issues that better characterize modern functionalist urbanism formed by isolated or open edification – high-rise blocks and towers - is the scarce coverage of the ground, with the radical inversion of the proportions between public and private spaces with respect to urban layout of the traditional city[12]. Only in some cases, as in the non-residential building plynths, the coverage is analogous to that of the traditional city (Pérez Igualada, 2005, 213).

The measurement of this parameter is more complex than it seems. Generally, only the footprint of the building is measured. If we want to differentiate housing estates with an abundance of spaces with undefined domains (interblock spaces) or even semi-public and private, we must take into account the variety of forms of land occupation, with spaces for housing, roads, parking, etc. (Fernández Per et al., 2015). Adapting A. Ferrer's categories to 'urban spaces in-between buildings', we consider the following groups: 'compact' (occupancy greater than 25%), 'average' (between 15% and 25%) and 'disperse' (less than 15%)[13].

Taking into account these considerations, compared to the usual generic interpretation that considers the coverage around 20% of the building, a certain diversity can be seen in the occupation of the land, which supposes different situations to consider in the formulation of treatment strategies of 'empty and full' (Figure 5).

04 Peripheral location. Is peripheral location a mark of identity?

In general, it can be said that most of the polígonos were located in areas with low level of urban accessibility. Therefore, during the first years, these residential complexes were very peripheral; they were characterized, above all, by their isolation with respect to the existing urban plots, with limited acces to services and infrastructures. On the other hand, the housing estates played an important role in the colonization of the periphery, as "pioneering enclaves that prepared the subsequent development of private bordering promotions" (Publich Housing, Grupo ADUAR, 2000).

Indeed, as anticipated, subsequent urban growth has substantially changed the relative position of many housing estates. Some now have a 'pericentral' position, since they no longer differ substantially from other forms of urban extension configured as 'first peripheries'. It is true that the equipment and infrastructures arrived later, but also contributed to a greater integration of the polígonos. In the sample analyzed, most polygons now have a relatively acceptable level of accessibility. Although it is also true that some are still autonomous parts of the consolidated city, which has not yet absorbed them, such as Ciudad Badía or Ciudad Meridiana in Barcelona or San Cristóbal de los Ángeles in Madrid. In these cases, the trend towards marginality is higher (Figure 4).

05 Enclave character. Are housing estates isolated islands in the urban fabric?

It is also of interest to consider the level of integration on a lower scale, that is, the relationships between the housing estates and their immediate surroundings. This is where the initial strong contrasts with the surrounding urban plots are appreciated, which in some cases have been diluted in a process by which they have fully incorporated into the city. In this process we must take into account the arrival of new cultural and sports facilities, social services, densification in adjacent

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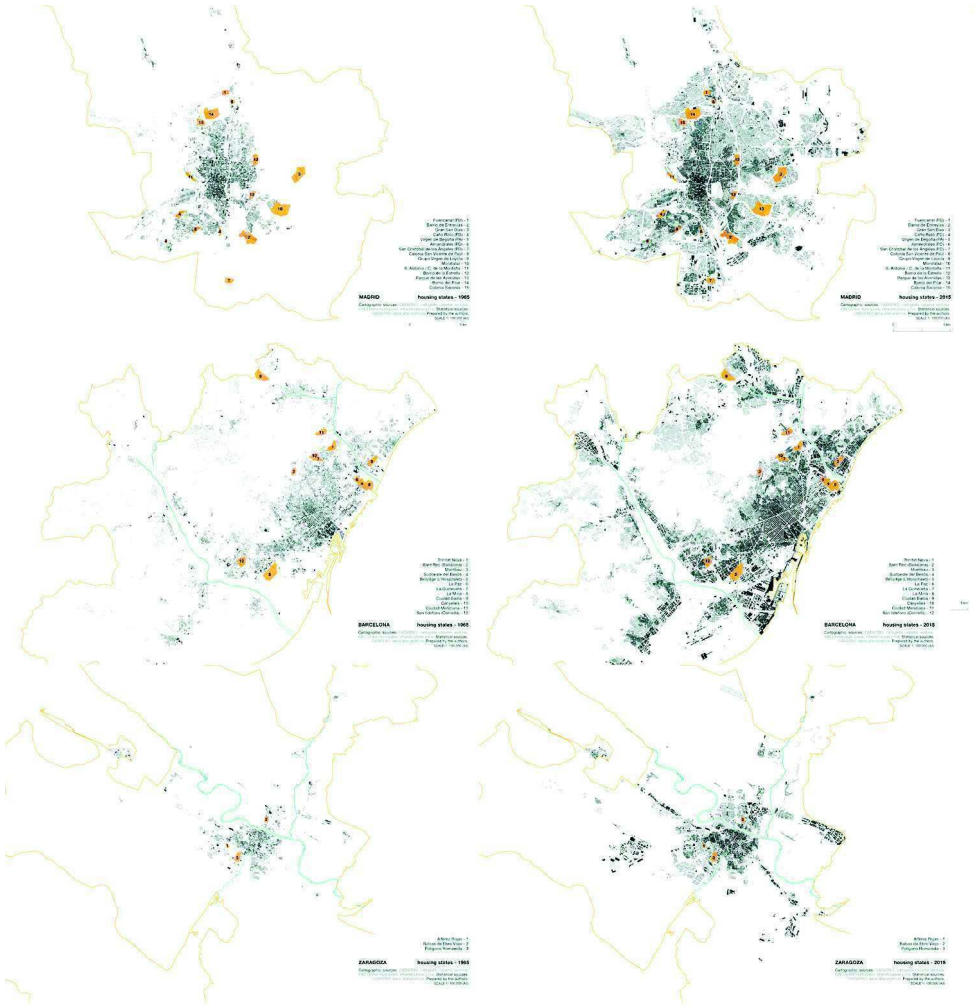

Figure 4.
Madrid, Barcelona and Zaragoza plans with the 32 examined polígonos in 1965 and in 2015. Graphic documentation elaborated by Sergio García within the framework of the project UR-Hesp. © Authors.

sectors, sometimes with the consolidation of neighborhood commerce. Road connections in the perimeter of the housing estates have also improved generally, as we saw in the previous section, so that the initial conditions of isolation are no longer so obvious. Howerver, many of them are still bounded by road infrastructure (San Cristóbal) or conditioned by their difficult topographical location, sometimes with a single access (Ciudad Meridiana). By analyzing in detail the evolution of adjacent urban fabric, we can verify the degree of physical integration of the polígonos[14].

Therefore, the low-scale study of the plot connecting the housing estates with their immediate surroundings is directly related to the evolution of the city and to the original urban forms that have sometimes favored and others have made integration difficult, the casuistry of cases being too diverse to be generalized (Figure 5).

06 Road system. Is the road system too specialized and hierarchical?

In the housing estates, as a consequence of the negation of the 'corridor street' and the 'closed city block', the canonical rationalist model is proposed: hierarchy of the road, with vehicles and pedestrian circuits that respond to nuclear and tree-like schemes, has a structuring character, but loses it when it is projected independently, apart from the other components of the urban structure, disregarding the functional implications and their formal relationship with them (Ferrer i Aixalá, 1996,

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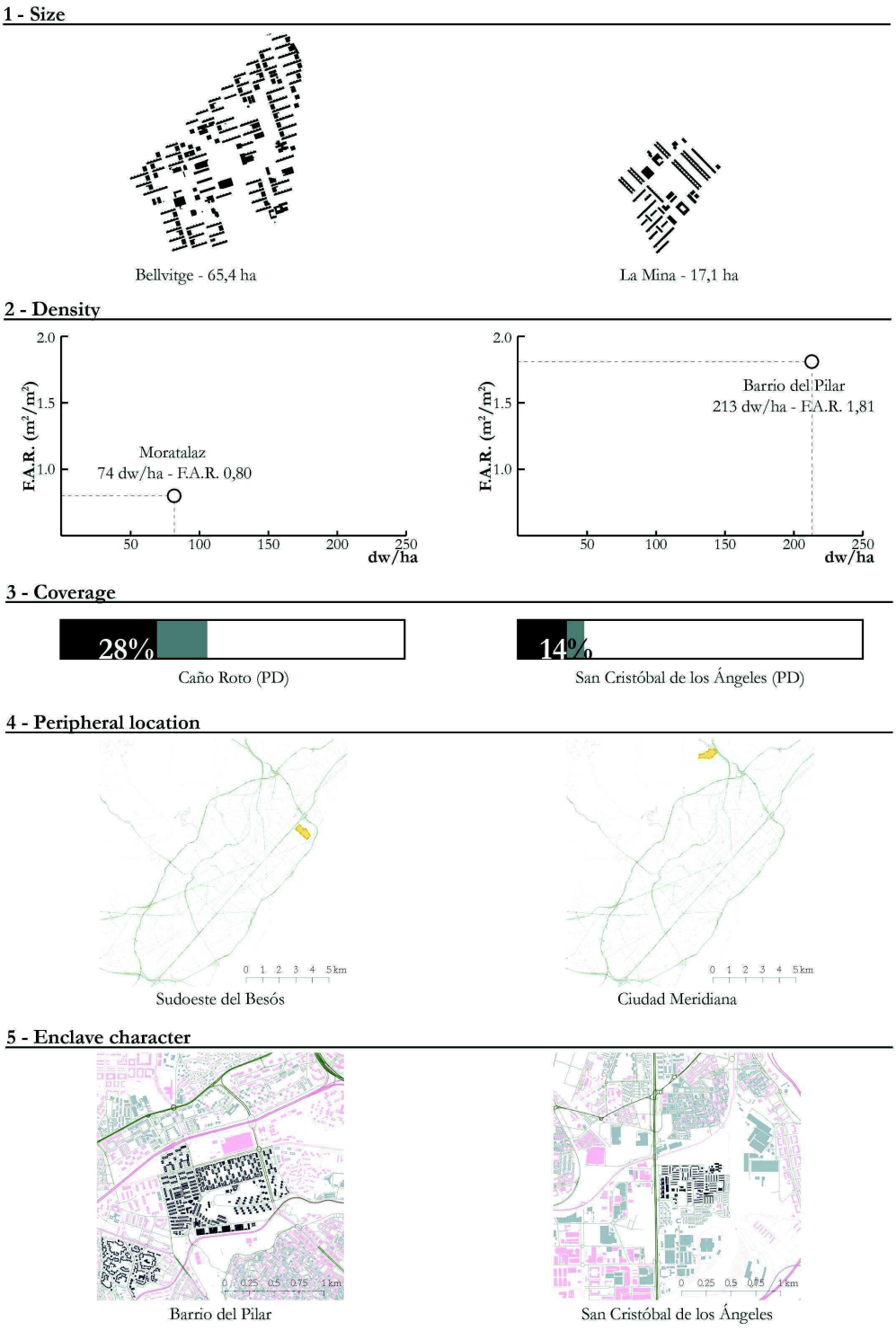

Figure 5.
Sample of some indicators studied in some specific polígonos which allow accurate diagnosis: size, density, coverage, peripheral location, enclave character. Graphic documentation elaborated by Sergio García within the framework of the project UR-Hesp. © Authors.

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57). On the other hand, "the section of the traditional street - with sidewalks, driveways and car parks in a single profile - is divided into independent sides that are separated from each other" (Rodríguez-Tarduchy et al., 2011, 135). Hence the 'little urban' character generally acquired by sets in which the functionalist scheme is more rigidly applied[15].

Considering the type of road system, at one end would be the housing estates that adopt an 'tree-like' structure (tree-like in terms of C. Alexander), that is, strongly hierarchical, and in the other those that start from a mesh or reticule in which are arranged the buildings, aligned or not to the roadways or to the streets and pedestrian routes. In any case, it is not so evident that urban quality depends directly on the more or less hierarchical character of the road system as its layout and design in relation to building (Figure 5).

07 Urban layout. Are monolithic tower and slabs responsible for poor urban quality?

Compositional poverty, the repetitive and monotonous urban forms of the housing estates and the monolithic arrangement of parallel blocks or isolated towers are the result of a commitment to the seriation and standardization of modern architecture and urbanism[16]. Exceptional testimony is the 'massive' housing complexes, which rise in the outskirts of cities[17]. From a formal and landscaping point of view, it is true that these housing estates, with the volumetric set of blocks and towers, present powerful images, especially at a distance. However, many of the criticisms of such ensembles point precisely to the excessive reliance on these visions 'from the air', almost always expressed in scale models.

From these functionalist principles, it is necessary to say that, while in some polígonos very few typologies and forms of aggregation are used (Bellvitge ...), in others several solutions are tested with articulated blocks (Saconia) or multiply the types and heights in order to achieve greater complexity and escape the monotony that results from repetition. Now, that is not a guarantee of success since it often falls into banal and arbitrary orders, thought as geometric exercises of composition in plan or in volume. It is also important to assess the relationships between occupancy and heights, in correspondence with compactness, parameters that are more difficult to quantify but which are fundamental for understanding the quality of urban forms[18] (Figure 5).

08 Open spaces. Are open spaces a no man's land?

For many authors, and also for the inhabitants of the housing estates, the existence of green spaces of greater extension than other neighborhoods is considered as one of the most positive aspects, but also a source of problems. The corollary of the alteration of the proportion between built-up areas and free space in the housing estates (see point 03) is the consequent hyperinflation of the 'green'. In fact, the partial plans developed under the 1956 Land Law had to zonify 10% of the total area as an urban park (A. Ferrer, 37). However, by adding 'interblock spaces', as well as private or community spaces, a much higher proportion is achieved. Such planning makes it difficult to maintain the character of 'green spaces' they had in the original projects[19]. Hence the criticism of these 'brown' spaces (open spaces) or 'gray' (car parks) (Díez Medina, 2015, 188–215).

Again, a variety of situations can be seen. At one end, there are some cases in which there is an overdrive of supposedly green spaces that are not so (San Blas, San Cristóbal, Sant Ildefons). However, there are also others in which large parks or wooded strips are an important element in the image of residential complexes (Loyola, Moratalaz, Salduba). The problem arises when these green areas are underutilized or do not act as an articulating elements. (See figure 2)

09 Land uses. Are housing estates bedroom communities?

Housing estates are usually characterized by a high level of functional specialization, due to their almost exclusively residential dedication. Either due to the nature of the initial projects, or due to problems of obsolescence in the types of equipment, the critical denomination of 'bedroom communities' has become widespread (Virgen de Begoña, Ciudad

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Figure 6.
Sample of some indicators studied in some specific polígonos which allow accurate diagnosis: road system, urban layout, open spaces, land uses, housing plots. Graphic documentation elaborated by Sergio García within the framework of the project UR-Hesp. © Authors.

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Meridiana, Ebro viejo). However, it must be considered that the Land Law of 1956 incorporated the land reserves for endowments, based on the conceptions of nuclear urbanism and the neighborhood units. The minimum standards of assignments for educational centers, services of public interest, etc., were added from this law to those corresponding to free spaces. Despite this, they frequently arrived late. Problems derive rather from the provision of these facilities, which often became real barriers, rather than elements of centrality and urban activity, as they were expected to be (San Blas plot G, Ebro Viejo)[20].

However, in other cases there have been shops and equipment of different types installed that have significantly activated urban life. Parque de las Avenidas, some 'superblocks' of San Blas or Romareda have much more urban life than the neighborhoods created in their surroundings on conventional urban plots. Again, the variety of cases makes it difficult to generalize criticism.

10 Housing plots. What is the impact of the 'disappearance of plots'?

One of the most relevant phenomenon that involves the application of the principles of functionalist urbanism and new forms of real estate production, with the imposition of the open block or the residential tower, is the disappearance of the plot as a support for building and the city block in the plot as a unit of composition. "The plot plan, which had sustained architecture until the middle of the XVIII century, disappears and the housing estate replaces the city block as a unit of composition and production" (Rodríguez-Tarduchy et al., 2011, 220). Therefore, the polygons are not structured anymore on the idea of plots or city blocks, which entails a considerable change in the way in which the building relates to the ground plane.

In the 32 polígonos analyzed, there are quite different situations. It is true that in many cases there are no other plots than those of the projection of the blocks (Alferez Rojas) and the towers, the rest being public space, being destined to road, equipment or free spaces, and being interblocking spaces the most confusing in terms of their ownership, therefore their maintenance (Entrevías, Ebro viejo). In contrast, in other cases, blocks and towers are associated with a private domain plot: this is where you can see more complex forms and intermediate spaces with different degrees of control, such as associated plots in Romareda or Estrella.

Conclusion/Epilogue

The criticisms generated by the modernist housing estates regarding the recognized rigidity of modern functionalist urbanism and the monolithic nature of urban forms are convincing. However, generalization is not very useful when a valuation that allows to determine possible strategies of intervention is sought. In this sense, what is important is to recognize the diversity of the obsolescence processes - and also the least considered of "resilience" or adaptability - that is evidenced in the analysis of the sample of 32 Spanish polígonos that has been carried out.

From an urban planning and an urban design perspective, the following questions arise: why do some polígonos age better than others? Depending on what factors? What role does urban design play in such processes? Which are the parameters that can help to control the problems and to take advantage of the opportunities that each of them offers?

More than forty years after the construction of these polígonos it is possible to understand the role that a series of factors of different order play in urban quality: from the relation with the urban plot, to the paths (more or less rigid and hierarchical), road systems, the size and layout of open spaces, the degree of segregation of uses, the characteristics of the plots, etc. The study of these factors in the analyzed sample allows to identify the most problematic situations, associated to the rigidity and lack of complexity of the initial options of its urban design, as opposed to others more resistant, flexible or more easily adaptable.

The identification of problems and opportunities in different cases allows us to think of strategies that can be very diverse and complementary: operations of densification and filling of gaps, when feasible, which in certain cases may favor a greater urban

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intensification; diversification of housing typologies; introduction of new non-residential uses; redevelopment and re-qualification of interblock open spaces; reconsideration of the plot plan to improve the control and maintenance of free spaces; improvements in the connection of the road system and pedestrian routes with surrounding urban areas, in those cases in which the enclave condition has not been overcomed; quality landscape treatment. All this, logically, in addition to the necessary interventions of rehabilitation of the buildings (improvement of energy efficiency, installation of elevators, etc.).

In any case, only by making an intentional diagnosis and analyzing the specifics of each case in depth, it will be possible also to refine the possibilities of regeneration and intervention strategies.

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Notes

1 Such as Churchill Gardens in Pimlico, London (1946–62), a true laboratory of high quality urban forms, or of the Roehampton flats in West London (Alton East and Alton West, 1953), an expression of the 'Corbusian dream' in the UK; also Pouillon exceptional grands ensembles in Paris, among them Résidence du Point du Jour (1957-1963); or Hansa Viertel in Berlin (1957-61).

2 Among others, Park Hill in Sheffield (1954-61), Bijlmermeer in Amsterdam (1968-1975), Gropiusstadt in Berlin(1966-1975), Tolouse-le-Mirail in Toulouse(1961).

3 Montbau in Barcelona(1960), Fuencarral in Madrid(1957), Salduba in Zaragoza(1958).

4 Ciudad Meridiana in Barcelona(1964), San Cristóbal de los Ángeles in Madrid(1959-??), Balsas de Ebro Viejo in Zaragoza(1964-75)…

5 In some cities, the urban characteristics of the polígonos of that period have been analyzed in a more or less systematic way (Bataller Enguix et al., 2004; Ferrer i Aixalá, 1996). There have also been important studies carried out from the perspective of the rehabilitation of the 'social housing slums' (García Vázquez et al., 2016). However, comparative visions are still scarce, whether among polygons in different cities or in the same city, that provide a systematic assessment of the diversity of urban situations and forms.

6 The definition of the Urban Geography Dictionary corroborates this reading: "The poligonos in Spain are, for the most part, concentrations of residential open building blocks" (Grupo ADUAR, 2000)(DGU, p.).

7 Among them: the double negation of traditional urbanity, that is to say, the negation of the corridor street and the closed urban block (manzana); the division between 'circulation' and 'recreation' and 'housing'; the commitment to the modern residential city as "a set of exempt and narrow linear blocks (without courtyards) arranged in parallel, transverse to the axis of road traffic"; the conception of the residential building as an isolated object, exempt by its four facades, independent; the erosion of boundaries linked to the disappearance of the plot; the radical inversion of proportions between public and private spaces; the hyperinflation of the 'green' (from 80%/20% to 20%/80%) (López de Lucio, 2013, 82).

8 The cartographic analysis has been mainly made from cadastral sources, historical cartography and current IGN, ... In addition, direct visits and own reinterpretation have produced thematic cartography as per the selected in figures 4 and 5.

9 Madrid's housing estates range from almost 20,000 homes in the El Pilar neighborhood, to 502 in the Juan XXIII group, with an average size of 4,610 homes (in the 16 analyzed); In Barcelona, they range from 13,055 from Bellvitge to 2,620 from La Paz, with an average size of 4,791; In Zaragoza, the range goes from 2,224 of Romareda to 230 of Salduba, with an average size of 1,161 homes.

10 Thus, in Madrid, in the 16 housing estates considered, the densities range between 74 homes/ha of Moratalaz and 213 dwellings/

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ha of the neighborhood of El Pilar (although large parks and general systems are counted in the first one), the average of 126 dwellings/ha. In Barcelona, the densities of the 12 selected polygons range from 85.7 homes/ha of Trinitat Nova to 203 dwellings/ha of Sant Ildefons, with a mean of 126.55 dwellings/ha (128.2 dwellings/ha according to the study of 32 Barcelona polígonos of A. Ferrer (Ferrer, 1974). The highest densities occur in slightly less than half of the polígonos, while those that are around 100 and 130 dwellings/ha dominate.

11 For example, they tend to be larger than those of the large French grands ensembles (Dufaux et al., 2004) or the English housing estates, with certain exceptions (Gold, 2007, 220).

12 While in the latter the ratio between built areas and open space (streets and squares, as well as parks) is 80% to 20% respectively, in the poligonos the proportion is inverse (in line with Colin Rowe's well-known figure-ground image, including housing, equipment and tertiary) (Bataller Enguix et al., 2004; Díez Medina, 2015; Ferrer i Aixalá, 1996).

13 In this way, we can contrast situations such as the 'compact' housing estate of Caño Roto (29%), Entrevías (27%) or Besós (27%), which present a larger footprint, compared to 'average' like San Blas (20%) or Montbau (19%), or the 'disperse' like San Cristobal (14%), Ciudad Badía (15%).

14 Sometimes, industrial uses have changed to residential (old Ebro); some empty urban spaces of the environment have been occupied by equipment and infrastructures (San Blas), while others have been left unoccupied (Caño Roto); some perimeter roads have become insuperable barriers (Entrevías, Fuencarral, San Cristóbal) or topographic barriers (Ciudad Meridiana) that have accentuated this enclave character; or have contributed elements of connection and continuity with other neighborhoods (Estrella, Moratalaz, Guineueta, Sudoeste del Besós, Ebro viejo); some have a mixed character, being integrated to the city but isolated by some of its edges (El Pilar, Almendrales, Alferez Rojas); in other cases, from the outset the polígonos were born with a vocation of integration in an urban plot in which their growth was foreseen, with a design that favored it, so that its status as enclaves has been canceled with time (Montbau, Besós, La Paz, San Vincente de Paúl.

15 Considering the wide range of solutions of road structure found in Spanish polígonos, we can classify them according to the three categories established by Amador Ferrer (1996, 190): 'branched' (Bellvitge, Moratalaz), 'isotropic mesh' (Romareda, Sudoeste of Besós), 'hierarchical mesh' (Guinegueta).

16 They also sought optimal orientation and solar gain criteria, as well as the possibility of cross ventilation as a fundamental criterion.

17 "(…) like regiments on the plans of a military school" (Urban, 2012, 45).

18 Thus, the neighborhood of El Pilar proves to be very compact, not only because of the occupation of land (23%) or density (213 homes/ha), or its average height (7,7), but also because of its urban planing. Some of the most successful examples are those in which control of the scale of buildings and spaces is achieved. Caño Roto, Saconia in Madrid, Montbau in Barcelona, Salduba in Zaragoza, among others (generally recognized by Do.co.mo.mo). Not by chance, these are the smaller ones. It is however more difficult to find bigger pieces in which a morphological complexity is obtained that allows the comparison with the urban plots of the traditional city. In some polígonos, such as Moratalaz or Gran San Blas, the different plots were solved with different projects, allowing each 'superblock' to be analyzed separately.

19 In relation to the 'green spaces': "The original project of these slums, based on the precepts of the Athens Charter, contemplated the integration of nature in the urban environment through large expanses of free space on which buildings were placed. However, at present, the natural ecosystem of these slums lacks diversity of vegetation" (García Vázquez et al., 2016).

20 The analysis is based on the quantification corresponding to square meters (m2)of residential area and assigned to other activities according to data extracted from the Cadastre.

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