Housing and community consolidation in informal settlements:

A case of movement economy

Margarita Greene

Pontificia Universidad Catolica de Chile, Chile

Abstract

This paper summarises the final findings of a five-year research project aimed at understanding the spatial factors that have affected the consolidation process of peripheral settlements in Santiago de Chile. The project included the collection of data on site, the development of new tools to measure consolidation and new ways of modelling urban space, as well as a programme of innovative representation techniques and statistical analysis. Previous results of this research, presented at the Third Space Syntax Symposium (Hillier et al., 2000), showed that the consolidation process of the peripheral settlements in Santiago was led by what was identified as an 'edge economy', which in fact was understood as an expression of what Hillier had previously described as the 'movement economy' (Hillier, 1996a).

Further and more detailed analysis is presented here, giving rise to some complementary new findings. Firstly, the building and analysis of 'parts of the city' syntactic models made clear that different sectors of the city undergo different consolidation processes, where the variables affecting them and their relative weight, change considerably. Secondly, a dual road system, composed of streets and small internal alleyways, was associated with very different patterns of movement. These in turn play different roles in the consolidation process. Thirdly, the role of the provision of infrastructure and urban services was clarified. Instead of being considered a product of consolidation, it is now considered an important independent variable necessary to set the whole process going.

1. Introduction

The massive extensive growth experienced by Santiago de Chile from the 1950s to the 1990s left the city with a vast, poor and under-serviced periphery, which has only recently begun to be incorporated into the benefits of urban life. The industrialisation process experienced by the country at mid century attracted massive flows of rural immigrants to the main cities in search of better opportunities. Santiago, as most large cities in Latin American, was unable to accommodate this new population that settled in the periphery in informal settlements characterised by

precarious physical and sanitary conditions. For a long time the authorities refused to acknowledge the existence of this informal city, the situation of these areas did not improve and eventually they turned into a health hazard for the urban population.

In 1982, Chile pioneered in Latin America the implementation of a 'Neighbourhood Upgrading Programme' (NUP) which established informal settlements on the land that they were occupying, legalising their situation and providing minimum sanitary conditions and infrastructure services. Normally the programme would involve the redesign of the whole settlement with a new orthogonal urban grid and a standardised division of plots (most of them forming rectangular blocks made up of 9 by 18 metre plots). Although the roads were initially unpaved and did not include sidewalks, they were marked with concrete kerbs, sign-posted with street names and house numbers (therefore providing a formal address to every dwelling) and provided with public lighting. Each plot, assigned and legally transferred to the head of the household, was provided with a small sanitary unit (between 8 and 14 m^2) including a toilet and kitchen fully connected to the drinking water, electricity supply and foul drainage systems of the city.

The building of the houses around the sanitary unit and the general consolidation of the areas that had been provided with minimum standards were left in the hands of the dwellers. Interestingly, these settlements which had a common origin and equal governmental intervention exhibit today very different degrees of social and physical consolidation: while some developed into residential areas with rich social communities, others remain in slum like conditions and show signs of social pathologies.

The question as to why some settlements should be more successful than others was the subject of the research presented here[1]. There are abundant evaluation studies on the consolidation of informal settlements[2] –and in particular on the Chilean NUP– but although some variables have been found significant, the explanation for the enormous differences in consolidation remains unsatisfactory. Most of these studies have been oriented to the identification of social and economic variables that could affect the settlements' process, without considering spatial or locational aspects.

Without denying the importance of the social and economic variables, the present research set to examine the spatial configuration of the settlements, particularly the way in which they are embedded in the surrounding network of streets. The hypothesis is based on the idea that spatial configuration can ultimately affect complex social process (such as, perhaps, consolidation) through the influence it has on the patterns of movement in streets. The latter have the potential for affecting the type of social community generated as well as economic activity.

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Much research has already found that the spatial configuration of streets plays an influential role in determining differences in the concentration of movement (Hillier et al., 1993; Peponis et al., 1989; Penn et al., 1998). Because patterns of movement affect land and space use, the spatial configuration seems to be critical at the generative level of many social processes (like the building of community networks, the development of commercial activity, the levels of crime, the satisfaction with the neighbourhood, and so on). Therefore, it is conjectured that the spatial configuration could also play a significant role in accounting for the divergent experiences of consolidation in the NUP settlements. The fact that the government provided only basic amenities and that so much of the process of consolidation was left to the inhabitants themselves, makes it an ideal case study to identify what conditions on site assist or hinder this process.

The research method involved three basic steps. The first was to build objective consolidation indices –housing, community and neighbourhood– that would allow measuring the consolidation process on site (Greene and Ortúzar, 2002). The second was the building of 'space syntax' computer models ranging from the whole city system to relevant parts of it; these provided the basic configurational measurements of the settlements. The third was the selection of 17 NUP settlements where relevant data was gathered, represented and analysed. This included the construction of land use maps, the application of a questionnaire with social and economic variables to 553 families, and movement observations in 489 gates in six separated hourly periods. The numerical data was represented in maps and graphs and statistically analysed. As the basic problem was to relate physical, social and economic variables (traditionally analysed non-spatially) to the spatial configuration of the settlements and their embedding in the more global systems, prior to the statistical analysis the data was represented in a Georeferenced Information System (GIS). This shed more light on the problem and helped to suggest working hypotheses.

The rest of this paper is organised as follows. Section 2 provides a brief summary of the main findings of the first stage of the research project carried out under EU funding (Hillier et al., 1998; 2000). The third section reviews the configurational analysis, incorporating some 'parts of the city' models of Santiago. The fourth section presents an analysis of the road structure, and pedestrian and vehicular patterns of movement, that clarified the space use in the settlements. The fifth section presents the analysis of the consolidation process undergone by the settlements at family level detailing the housing and community consolidation processes. Finally in the sixth and final part of the paper three aspects that characterise the movement economy process of the informal settlements in the Chilean periphery are pinpointed, and some theoretical, methodological and policy contributions raised by the research work are put forward for discussion.

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2. The Movement Economy

The main findings of the EU stage of the research can be summarised as follows (Hillier et al., 2000):

- Spatial and locational factors, especially the layout of the settlement and its relation to its urban context, have played a major role in the pathway of development of the settlements and the different degrees to which they have become consolidated.

- The critical spatial factor in the development of the settlements is the degree to which the settlement is able to develop 'edge oriented commercial activity' through its outward facing edges, and through this to participate in a wider local economy.

- The critical spatial property that sparks off the process is 'local spatial advantage', meaning the degree to which the settlement is spatially integrated with respect to its local contextual area of 1.5 km radius and 7 km^2 in area.

- A prime determinant of the development of this type of economic activity is the direct adjacency of outwards facing settlement edges to streets and roads with significant local vehicular movement, and the accessibility of the internal layout of the settlement to the lines on which this occurs.

- Where this 'edge oriented commercial activity' is strong, the overall level of self generated economic activity in the settlement increases.

- This then has a series of beneficial effects: the reported experience of mugging and burglary (but not necessarily of drugs and alcohol) in the settlement is lower, there is greater consolidation of houses, and there is a higher level of community development. These last two give a higher level of overall consolidation in the settlement.

Thus, the research findings strongly relate to a generic socio-spatial process by which urban space is built, lived and understood, described as follows:

"In 'Natural movement' (Hillier et al., 1993), it was shown that the structure of the urban grid has systematic and independent effects on movement patterns, which could be captured by 'integration' analysis of the axial map. In 'Cities as movement economies' (Hillier, 1996a) it was shown that natural movement –and so ultimately the urban grid itself– impacted on land use patterns by attracting movement-seeking uses such as retail to locations with high natural movement, and sending non-movement seeking uses such as residence to low natural movement loca-

tions. The attracted uses then attract more movement to the high movement loca-
tions, and this in turn attract further uses, creating a spiral of multiplier effects and
resulting in an urban pattern of dense mixed use areas set against a background of
more homogeneous, mainly residential development. In 'Centrality as a process'
(Hillier, 2000) it was then shown that these processes not only responded to well-
defined configurational properties of the urban grid, but also initiated changes in it
by adapting the 'local grid conditions' in the mixed movement areas in the direction
of greater local intensification and 'metric integration' through smaller scale blocks
and more trip-efficient, permeable structures." (Hillier, 2001).

Yet, although the above argument helped to explain the consolidation process
lived by the peripheral settlements in Santiago to a large extent, there were still
some questions that needed to be answered, especially if the final aim was to offer
planning or design recommendations.

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3. Syntactic Modelling

To further understand the role that the spatial variables were playing in the
consolidation of poor settlements, some additional ways of modelling the city were
carried out. In the EU stage of the project Santiago had already been modelled and
analysed syntactically in more than one way.

First, it had been modelled in four equal span moments –1890, 1925, 1960
and 1995– associated with important planning interventions[3] (Figure 1). The analysis
showed that in each of these moments the configuration of the city changed
significantly and left a trace that can be recognised until today. The 1890 intervention
set off an "inner CBD" *(el centro)* that encompasses the central banking area, major
commercial roads and governmental buildings. The 1925 intervention consolidated
the inner CBD and gave origin to what can be described as a "greater CBD" that
includes the first periphery of the centre providing services at metropolitan level. In
fact, just like the inner CBD boundaries coincide to a great extent with the
Circunvalación, the greater CBD boundaries coincide with the *Camino de Cintura*,
both ring roads set up in Vicuña Mackenna's masterplan. The 1960 intervention not
only defined three "fundamental corridors" –west-east, north-south and ring road–
which are present until today in the city (Parroquia, 1979) but also incorporated four
areas that historically had been independent urban settlements: San Bernardo, Puente
Alto, Maipú and Quilicura. Finally, the 1994 intervention is associated with the
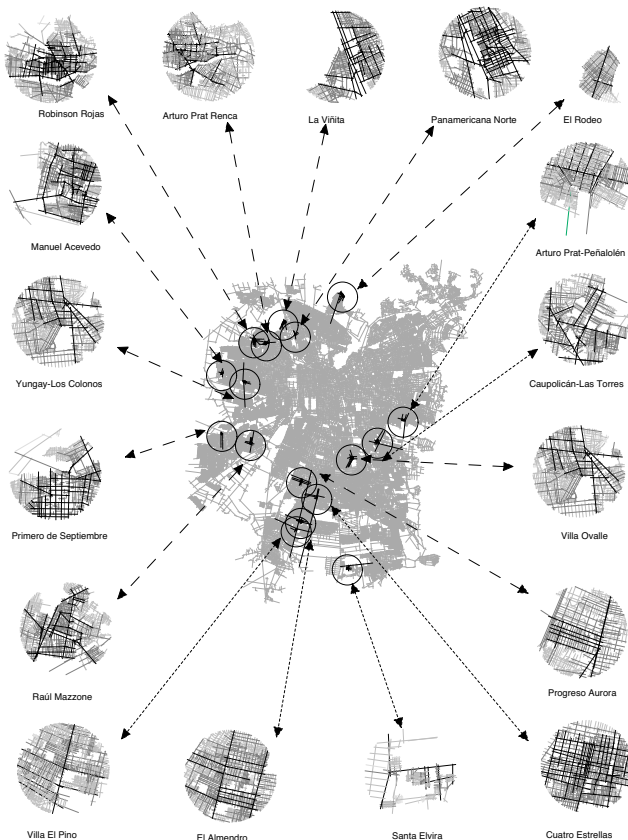structure of the city today.

Figure 1: Global integration maps in four historical moments

1890   1925   1960

1995

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Second, a set of models had been built by cutting out 7 km² circles of the city grid around the 17 settlements under scrutiny (see Figure 2). This was based on the idea that the basic system affecting the social and economic process would be no bigger than a "walkable" distance. Therefore, artificial circular systems were built by defining a circle of 1.5 km. around the settlement. Each one of these circles was modelled and analysed as an independent system. These models were important in the final analysis as they allowed first glance differentiation between the settlements and were the best predictors for movement.

Figure 2: Crcular models at integration radius_n

Robinson Rojas   Arturo Prat Renca   La Viñita   Panamericana Norte   El Rodeo

Manuel Acevedo

Arturo Prat-Peñalolén

Yungay-Los Colonos

Caupolicán-Las Torres

Primero de Septiembre

Villa Ovalle

Raúl Mazzone

Progreso Aurora

Villa El Pino   El Almendro   Santa Elvira   Cuatro Estrellas

Based on the previous analysis the last part of the research, reported here, added a third type of configurational model: 'parts of the city' models. The fact that the whole-city models of 1995 did not show the importance of the richer *Oriente* sector of the city, together with the intuition that in a big urban system such as Santiago (with almost 32,000 axial lines), its inhabitants do not actually use the whole system, brought the idea of analysing parts of the city as independent systems. The conjecture was that these might indicate more accurately the effect that spatial variables were having on the social and economic process. For somebody living in the south of the city, going to or using its northern part would be comparable to going "out of the city", since the every day system they inhabit includes only a fragment of the whole system.

Two criteria were used to build the 'parts of the city' models. The first one was to recognise existing fragments due to natural or man-made barriers. The second was to isolate the old districts that became part of the city fairly recently (San Bernardo, Puente Alto, Maipú, Renca and Quilicura).

Four fragments models

As Santiago is a very centralised system, the first decision regarding the construction of fragments was that all should include both CBDs (inner and greater CBD). For the majority of the population (probably with the only exception of the richer *Oriente's* inhabitants) the historical triangle is still the social and commercial centre of the city. Following that decision, the fragmentation of Santiago was done on the basis of existing natural and man-made barriers. Seven such barriers, shown in Figure 3, were detected: (i) San Cristóbal Hill (ii) Peñalolén urban gap (iii) Cerrillos Airport; (iv) Route 68 highway; (v) Mapocho River; (vi) Renca Hill, and (vii) Panamerican Highway

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These barriers allowed division of the city into four segments (Figure 4), which were modelled independently. The 'four segments model' was then built by joining the modelled parts to the CBD sector modelled for the whole of Santiago. The representation of this model in Figure 5 shows an integrated centre of the city (the greater CBD) expressed in concentrations of darker lines, given by the whole city model, and sub-centralities in each segment. With the exception of the rich east sector (*Oriente*), where an important sub-centre has developed in recent years, the rest of the sub-centres seem to be overstated in relation to their actual importance. Nevertheless, in recent years there have been signs that the traditional mononuclear characteristic of Santiago is starting to break through emerging sub-centres located in the periphery, which coincide with the integrated areas shown in the four segments model.
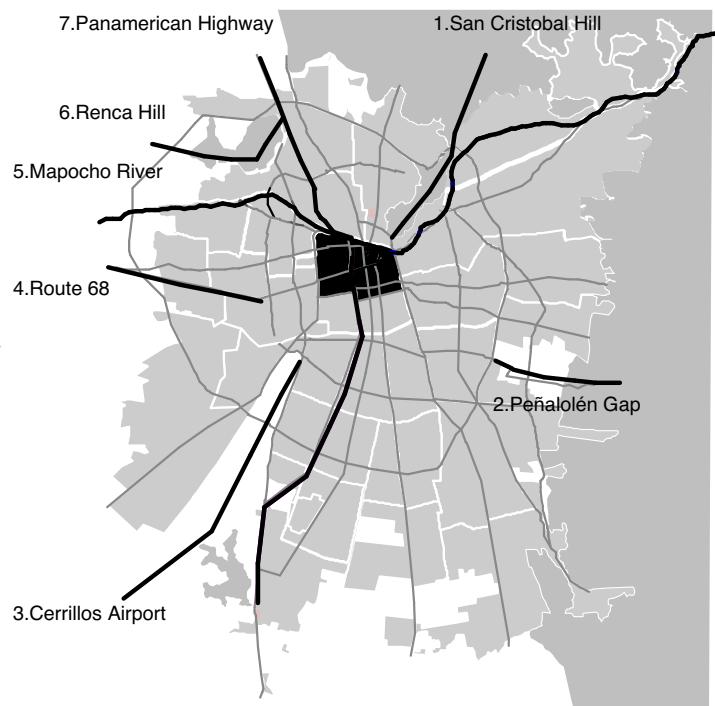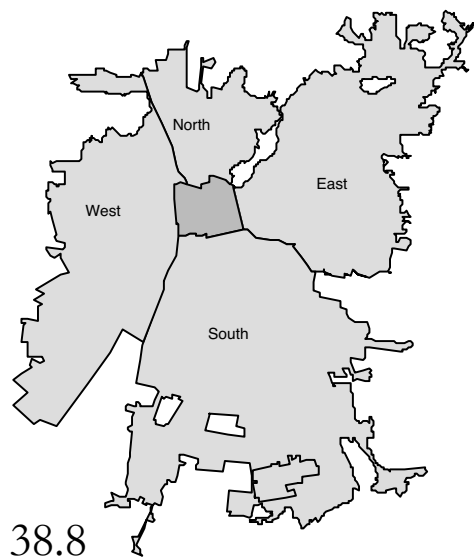

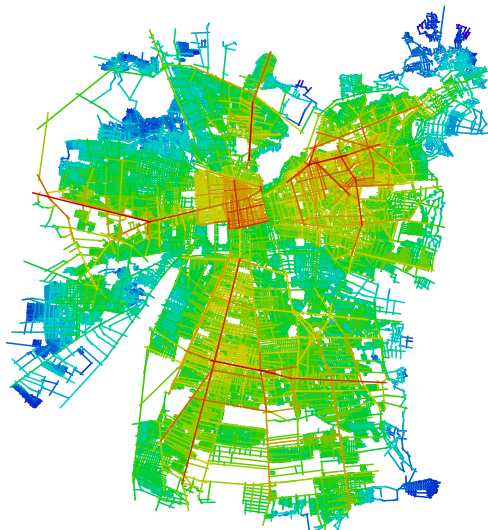**Figure 3: Natural and man made barriers in Santiago**

Another observation from the model is that it reflects the traditional doughnut effect typical of American cities –a ring of obsolescence surrounding the centre of the city– that is also present in Santiago.

Figure 4: Santiago split into four segments

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Figure 5: The four segment model at integration radius_n

But probably the most important observation from this set of syntactic maps arises when modelling the east segment –known as *Oriente*, where the rich inhabit– as an independent system, since it shows a very clear match between commercial land use and spatial integration that fails to show in the whole city models. The integration core within the segment considered alone (especially at radius-n and radius-9 levels) directly mirrors the commercial development axes of Providencia, Apoquindo, Kennedy and Las Condes, while the lighter segregated areas concentrate the most exclusive residential areas. The fact that this part of the city needs to be modelled independently to coincide with the actual development, shows in spatial terms what has already been shown in social and economic terms: Santiago is not one but at least two cities. Thus, the spatial model directly reflects the conjecture of "two cities", which postulates that the rich and poor areas of Santiago are virtually independent of each other (CED, 1990).

Older districts model

As mentioned above, in the periphery of the city there are five districts that had an independent origin from Santiago and still maintain certain independence from the main city. Four –Maipú, San Bernardo, Puente Alto and Quilicura– were only adjoined to the city at the end of the 1960s; Renca was incorporated to Santiago previously but due to its geographic condition still preserves a degree of independence. This suggested the idea of excluding these 'older districts' and modelling the main city (without these districts) and each district separately as independent systems (see Figure 6).

The graphic representation of these models mirrors quite accurately the development of the areas: the actual shopping streets, downtown areas and "Plaza de Armas" are all located in the most integrated nucleus. In Figure 7, the model of the city built by joining these five models into the city model where these had been excluded, is presented. This final representation of the city is what will later be referred as the older districts model.

Just like the east segment model directly mirrored the development of the *Oriente* sector as an independent system, and in doing so corroborated the "two-cities" hypothesis, this new model seems to reflect that segregation for the rest of the areas is a different phenomenon. Marcuse and Van Kempen (2000) offer a new way of understanding segregation, what they call "layered cities". They believe that the traditional image of spatial segregation as divided sectors (what they call

quartered) does not reflect the complex relations of urban life. Given that different people can use the same space in different ways and at different times, urban systems should be understood as composed of layers, rather than of quarters or sectors.

In the case of Santiago, the models seem to show that the two types of segregation co-exist. The traditional spatial segregation or divided city syndrome separates the richer population from the rest of the system. For this particular socio-economic group the city where they live and which they use effectively is only the east part of the city: the *Oriente* segment. On the other hand, for the rest of the population the system seems to include a much wider area. In fact, while the richer population does not use, visit or know the poor sectors of the city, much of the poor population goes daily to work to the east sector. Likewise, many of the inhabitants of Santiago do not use, visit or know the older districts, while their population visits daily and depends on the central city. In that sense Santiago seems to show that both types of segregation not only exist but can share the same urban space: i.e. quartered and layered segregation.

3. Road Structure and Space Use

The EU funded stage of the project signalled the importance of the settlement borders, especially when they hosted commerce, and developed what was called an 'active edge'. Nevertheless it was not always easy to identify this active edge in a precise way. Although most of the time it coincided with the perimeter of the settlement and with a fairly busy road, there were cases when the settlement was embedded in a homogeneous area, its edge was very similar to the internal streets and did not hold the active commercial activity. On the other hand, there were cases when an important road crossed the settlement and the 'active edge' seemed to be acting through the centre of the settlement.

The road structure of the NUP settlements is quite characteristic: it includes streets (at least seven metres carriageway plus two sidewalks, totalling ten metres wide) and alleyways (six metres wide, with a three metres wide central pavement shared by cars -almost exclusively of residents- and pedestrians). The street system connects the settlement with the city while the alleyways provide internal connections. Although there is a tendency for the streets to surround the settlement and the alleyways to feed them internally, there are cases with street penetrations, sometimes forming a ring or –although exceptionally– crossed by streets.

Figure 6: Santiago split in main city and older districts
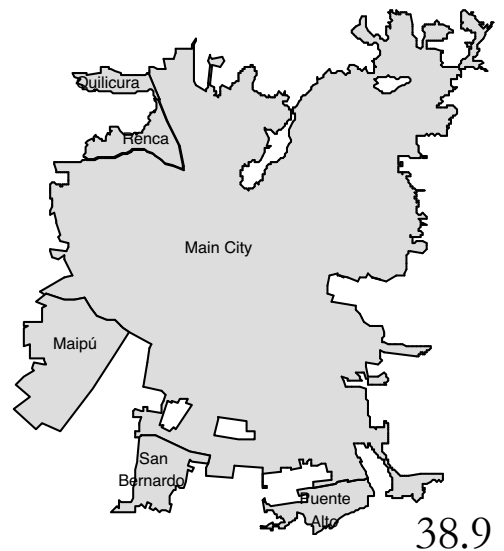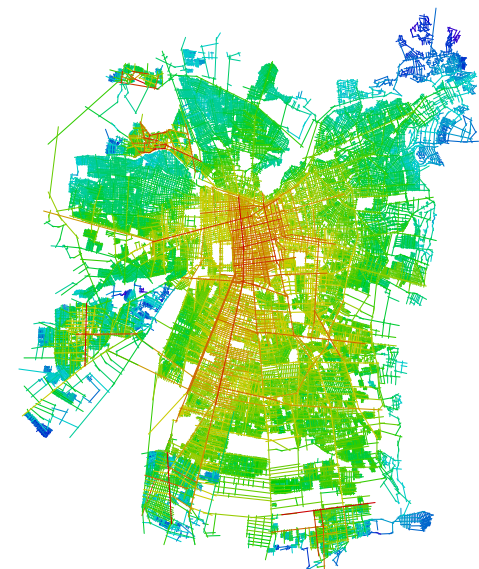

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Figure 7: Older districts model at integration radius-n

A natural next step was to check if this morphological differentiation between streets and alleyways was related in any way to space use. Many authors have underlined the importance of the presence of people in urban open space. Special reference needs to be made to the classic book by Jacobs (1961), where the importance of street life in the formation of residential communities and healthy citizens is stressed. In that line, twenty years later, Hillier and Hanson (1984) developed the concept of virtual community, referring to the potential social interaction field generated by the urban grid. The novelty of this concept was the relation of the spatial characteristics of the grid to a probabilistic social field. More recently, Hillier (1996a) carried on his approach further and postulated the 'movement economy', where movement patterns are considered not only an expression of social well being, but also part of a powerful mechanism by which urban space can develop and consolidate.
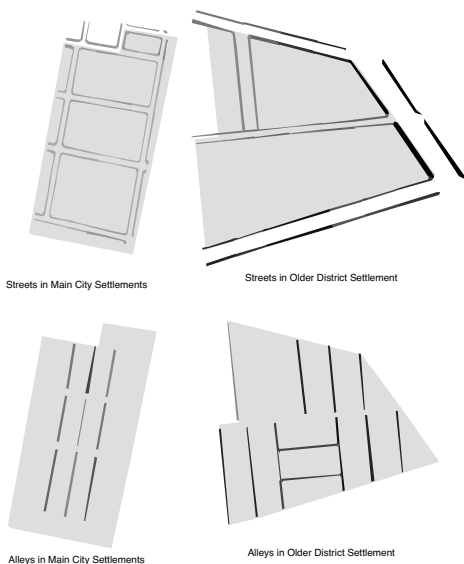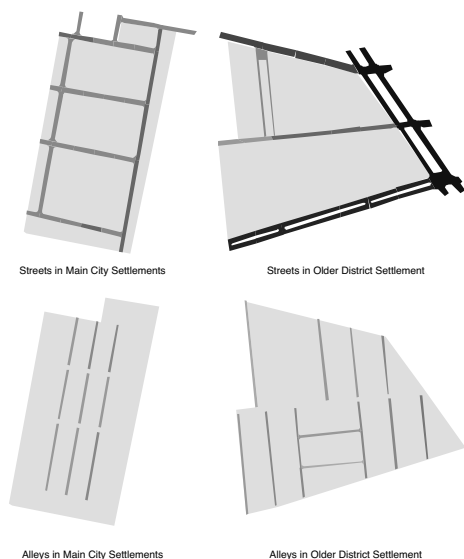
The space use analysis carried out in the 17 settlements showed that vehicular movement is almost totally concentrated in the streets (93.6% of the vehicles observed were on the street system), while pedestrian movement becomes predominant in the alleyways (82.8% of the observed movement corresponds to pedestrians, but this proportion falls to 32.7% in streets). Therefore, a pattern of movement in the settlements was emerging characterised by internal pedestrian movement with almost no vehicular movement, and abundant pedestrian and vehicular movement in the perimeter.

These different movement patterns suggested a further exploration in the main city and the older districts category. A set of unpaired t-tests for the significance of the difference between the main city and older districts was carried out separately for streets and alleys. This disaggregate analysis allowed differences to show up that had been obscured before.

In summary, the analysis of pedestrian movement showed that: (i) streets have higher rates of pedestrian movement than alleys (ii) older districts have higher rates of pedestrian movement in streets than those in the main city (iii) women have a higher presence than men and children, specially in streets (iv) alleys in the main city have significantly more men and in the older districts significantly more women. Regarding vehicular movement, the streets of the older districts have significantly higher movement than the main city; on the contrary, vehicular movement is kept quite stable in alleys (see Figures 8 and 9 for GIS representations

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Streets in Main City Settlements

Streets in Older District Settlement

Alleys in Main City Settlements

Alleys in Older District Settlement

Figure 8: Pedestrian movement in streets and alleys

Streets in Main City Settlements

Streets in Older District Settlement

Alleys in Main City Settlements

Alleys in Older District Settlement

Figure 9: Vehicle movement in streets and alleys

of pedestrian and vehicular movement). These differences proved to be important in the development of community ties, commercial activity and the general well being of the settlements.

4. The Consolidation Process

Finally, the task of unveiling the complex process of consolidation in the peripheral settlements was approached through a series of statistical analyses. The first stage involved testing social, economic, morphological, configurational and land use variables in prima facie relationships with the three consolidation indices: Housing Consolidation Index (HCI), Community Consolidation Index (CCI) and Neighbourhood Consolidation Index (NCI).

This first analysis allowed the identification of 18 relevant variables affecting the process of consolidation (see Table 1). These were used to build stepwise regressions for the three indices at settlement and family levels. Given that the number of cases at family level allowed the comparison between the consolidation process of the main city and older districts settlements through multiple regressions[4], this paper will concentrate on this level.

The stepwise regressions made for the three indices with selected indicators of the relevant variables show that the predictions of HCI and CCI improve for the main city but weaken for the older districts. A second observation is that older districts tend to correlate better with the segments model, while those located in the main city with the models that exclude the older districts. But probably the main result of the analysis at this stage was a change in the argument regarding neighbourhood consolidation: from a process to be explained (defined as NCI) to an intervening variable in the consolidation process of the settlement.

This happened because the NCI index was proving difficult to predict (probably because the development of neighbourhood infrastructure and services is more a product of political and administrative factors than a result of the inhabitants' social and economic resources, or the settlements' spatial and land use characteristics), while at the same time recent studies of social housing were identifying the neighbourhood infrastructure and services as the most relevant aspect for the development of informal settlements (see for example Fiori, 2001; Brakarz et al., 2002). Therefore NCI was incorporated in the analysis as an independent variable contributing to the community and housing consolidation process.

This also opened the possibility of incorporating the other indices –CCI and HCI– or some of their attributes, sub-components or components, as additional independent variables affecting the other index.

38.11

Table 1: Relevant variables related to consolidation

Social
1   Time in settlement
2   Size of family group
3   Family Type by kinship
4   Parental family type
5   Stage in family cycle
6   Education level
7   Occupation type

Economic
8   Dependency rate in family
9   Income stability
10 Amount of income

Configurational
11 Settlement Design
12 Global integration
13 Local integration
14 Connectivity
15 Local spatial advantage

Land Use
16 Pedestrian movement
17 Vehicular movement
18 Commerce development

The last aspect to be included in the analysis was the subjective valuation that the inhabitants have of aspects related to their residential situation. The idea behind this is that the efforts and resources that the inhabitants are willing to dedicate to their community or to invest in their houses, should also relate to their satisfaction regarding their residential situation. Notwithstanding, the criteria was to not include the valuation of the same aspect that was being analysed (i.e. valuation aspects on the neighbourhood and house were tested with CCI, and valuation on community and neighbourhood aspects were tested with HCI).

Table 2: Multiple regression for CCI at family level

	ALL SETTLEMENTS CCI vs. 10 Independents		MAIN CITY CCI vs. 10 Independents		OLDER DISTRICTS CCI vs. 7 Independents	
Count	422		259		165	
Num. Missing	12		7		3	
R	0.400		0.494		0.431	
R Squared	**0.160**		**0.244**		**0.186**	
Adjusted R-Squared	0.140		0.214		0.150	
RMS Residual	14.647		13.640		14.920	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Intercept	78.432	<.0001	97.374	<.0001	57.420	<.0001
Both parents			-4.142	0.047		
Education level			-1.594	0.039		
Nuclear family	-4.758	0.015				
Independent ocassional	-5.628	0.016	-9.555	0.001		
Independent stable			5.475	0.024		
ln(x) of income per capita	-2.691	0.026	-3.669	0.020		
Spending per capita/1000					-0.152	0.035
Plot in street	3.835	0.033			5.147	0.058
Integrat.R-n in segm.model	6.896	0.001				
Integr.R-3 in segm.model	-12.477	<.0001	-9.432	0.001	-2.251	0.093
Connectivity in Stgo.model	0.254	0.000	0.208	0.046	0.370	0.001
LSA at R-3	24.571	<.0001	21.248	0.001		
Mean pedestrian movem.					-0.092	0.094
Mean vehicular movement					-0.027	0.016
Community buildings					2.602	<.0001
Recreational space	1.027	0.010	1.272	0.013		
Inhab.valuat.of locat.in city	1.143	0.027	1.424	0.011		

Community consolidation process

Table 2 presents the best multiple regressions produced to explain the community consolidation process at family level after having considered the social and economic characteristics of the inhabitants, the configurational, space and land use aspects of the settlements, the conditions of the housing and neighbourhood and the subjective valuation as perceived by the inhabitants of their residential situation. Some observations derived from these regressions are the following:

- Although the prediction of the community consolidation process does not present high statistical coefficients, due to the subjective characteristics of this aspect they can be considered surprisingly strong;

- the regressions improve when separating the sample according to their location in the main city or in the older districts, thus suggesting that the two-process conjecture is reasonable;

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-       social resources are important in the main city settlements and in an inverse relationship to consolidation: that is, with fewer social resources there would be a tendency towards stronger development of community relationships, thus supporting the understanding of community networks as a survival strategy among the weaker groups in harder conditions;

-       the same is true for economic resources both in main city and in older districts' settlements: at lower resources higher CCI;

-       local integration seems to act against community consolidation, while connectivity and 'local spatial integration'[5] act positively, although the last one only in the main city settlements;

-       movement patterns, both pedestrian and vehicular, act as negative factors in the development of CCI in the older districts, although in these same settlements the location on a street (as opposed to an alleyway) is an advantage for CCI;

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-       in the case of main city settlements, a positive evaluation regarding the location in the city is directly linked with the development of CCI;

-       the fact of having a certain neighbourhood infrastructure acts as a positive element to aid consolidation in all settlements although the type of infrastructure varies from one group to another. In the main city, the important elements refer to recreational space (that is plazas, playgrounds and sports ground) while in the older districts they refer to community buildings (for minor or formal local organisations).

Table 3: Multiple regression for HCI at family level

	ALL SETTLEMENTS		MAIN CITY		OLDER DISTRICTS	
	HCI vs. 8 Independents		HCI vs. 6 Independents		HCI vs. 7 Independents	
Count	432		266		167	
Num. Missing	2		0		1	
R	0.558		0.611		0.560	
R Squared	**0.311**		**0.373**		**0.313**	
Adjusted R Squared	0.298		0.353		0.283	
RMS Residual	13.036		12.950		12.420	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Intercept	36.643	<.0001	31.876	<.0001	26.019	0.016
Persons in family	-2.169	<.0001	-2.208	<.0001	-1.427	0.003
Simple nuclear family			3.062	0.077		
Both parents	3.175	0.044				
Growing family	-8.863	0.011			-12.780	0.009
Ownership of consumables	5.677	<.0001	6.817	<.0001	4.557	<.0001
Income/1000					0.036	0.000
Spending/100	0.054	<.0001	0.060	<.0001		
Plot in street			-2.942	0.101		
Shop in street			7.568	0.081		
R-n in older district model	3.622	0.040				
R-n in seg+old dist.model			7.241	0.010		
R-n in segments model					9.325	0.000
NCI	0.107	0.047				
Urban service & equipmente					1.135	0.057
Urbanization					0.354	0.011
Inhab. valuation of community	1.406	0.002	1.955	0.000		

Housing consolidation process

Table 3 presents the best multiple regressions produced to explain the housing consolidation process at family level after having considered the social and economic characteristics of the inhabitants, the configurational, space and land use aspects of the settlements, the conditions of the community and neighbourhood, and the subjective valuation of their residential situation by the inhabitants. Some observations to point out from these regressions are the following:

- The prediction of housing consolidation is stronger than the more subjective community consolidation;

- the regressions also improve when the sample is separated according to location in the main city or in the older districts, suggesting that the two-process conjecture is acceptable;

- social and economic resources –although expressed through different indicators– are important factors for the development of housing consolidation in both the older districts and the main city settlements;

- global integration –although measured in different systems– is also an important factor in the development of housing consolidation in both groups;

- in the case of main city settlements, the families that are located in streets are at a disadvantage with those located in alleys, unless they develop a commercial activity, in which case this becomes an advantage;

- certain aspects of the infrastructure are important for the development of HCI in the older district settlements (specifically the provision of urban services and equipment, such as public telephones, primary schools and health centre);

- in the main city settlements the valuation that inhabitants make of their community is an important factor for the housing consolidation.

6. Final Considerations

The research presented here aimed at understanding the spatial factors that have affected the consolidation process of peripheral settlements in Santiago de Chile. The results of the study are summarised in this last section in two parts: the first focuses on those related to the 'movement economy' theory, and the second puts forward the main contributions that this work raised: on the theoretical, methodological and planning realms.

38.14

The Movement Economy

Additional thorough analysis of the data and the production of models at a more detailed level allowed further understanding of the movement economy process described in Hillier (2000). The new findings complement and clarify the consolidation process of the peripheral settlements in Santiago by identifying the following three aspects:

-        the role of the provision of infrastructure and urban services (neighbourhood aspect);

-        the differentiation between movement in streets and alleyways (community aspect);

-        the recognition of a different consolidation process according to the settlement's location in the city: main city or older districts (housing aspect).

38.15

Infrastructure and urban services

The last finding that illuminated the consolidation process undergone by the peripheral settlements of Santiago de Chile was the fact that the infrastructure and urban services were not a product of the consolidation process amenable to measurement through an instrument such as the 'Neighbourhood Consolidation Index', but an important intervening variable necessary to set the process going. In this way, it should be considered and used as a trigger for consolidation.

This aspect has been now recognised by Latin American governments, which have dedicated significant efforts during the last years to implement Neighbourhood Upgrading Programmes (NUP) based on the effect that the supply of urban infrastructure has on poverty alleviation. Current examples of these are the ongoing Habitar Brasil, Favela Barrios and Baixada Viva in Brasil, PROMEBA in Argentina, Subprograma Mejoramiento de Barrios in Bolivia and Programa Mejoramiento de Vivienda y Entorno in Colombia, as well as the Chile Barrio programme.

In fact, the differentiation of the housing and community consolidation process from the neighbourhood aspect was vital to understand the previous two. The first two are indicators of physical and social processes of development where spatial variables have an important role to play, while neighbourhood development follows a political agenda –especially in the case of NUP settlements– but becomes an essential factor to set the consolidation process in motion.

This must not be understood as a restriction, but on the contrary, as an important tool through which governmental action can detonate a natural process, such as the movement economy, which would contribute significantly to urban

development and quality of life.

Streets and alleyways

In the EU stage of the research and in line with the movement economy theory, an 'edge oriented commercial activity' process which set in motion the consolidation process of the settlements was identified. In this last part of the research, this process was further associated to a morphological characteristic of the settlements, therefore clarifying the argument.

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The informal settlements later upgraded through the NUP follow a very typical design in Santiago: due to the scarcity of resources and in search of maximising land occupation the planning regulations are stretched to their limit and have given rise to a typical layout design that varies from one location to another but has turned into a sort of genotype. It can be described as a ring of peripheral streets, with internal alleyways ('*pasajes*') that give access to the individual plots. The peripheral streets are normally linked with the city, and therefore coincide with the more integrated lines of the settlement; the internal alleyways, instead, often do not even coincide with the lines of the neighbouring settlement, and therefore are often segregated. The former then concentrate most of the vehicular and passing movement, while the latter harbour the local movement and the settlement's inner life, a mainly pedestrian activity.

With this distinction in mind, it is easy to understand the difference between commerce in streets and alleyways. Commerce in alleyways is only directed at the internal inhabitants of the settlement, therefore has little economic relevance. Commerce in streets, on the other hand, also attends the neighbouring area. Therefore, if the settlement is well integrated in its local contextual area, it can become a powerful mechanism to bring in resources from outside the settlement.

This explains the powerful regression between street commerce and vehicular movement (r-square of 0.86 in main city and 0.81 in older districts settlements). It is not that this small scale commerce is stopping ongoing vehicle movement –which in exceptional cases it does– but that it is profiting from pedestrians passing by on their way to other places. Thus, the movement economy seems to be working again.

Apart from giving a more objective measure of this phenomenon, this differentiation allows us to understand certain paradoxes or unanswered questions. To understand for example why it was difficult to associate pedestrian movement with the consolidation process on the settlements, while on the contrary consolidation

appeared to be directly linked to vehicular movement and specifically to natural vehicular movement (measured through the regression coefficient of vehicular movement and spatial configuration).

The fact is that work on site indicated that pedestrian movement could be the expression of very different social phenomena: from buzzing commercial nodes, to groups of threatening youngsters in control of public space, as well as typical residential activity of children playing and parents watching. On the contrary, vehicle movement in streets (and especially in these sorts of residential street) is much more the product of urban configuration and is always the expression of ongoing movement. Even more, a poor coefficient in the regression between vehicle movement and configuration is a good indicator that there is low natural movement, which according to the movement economy is the vital ingredient to set the process in motion.

38.17

Finally, it is important to underline the importance of the development of commerce in streets, especially in the main city settlements, where it is possible to see that being located in a street is a negative condition for the development of HCI, which turns into a positive asset if the family develops commercial activity in the plot (Table 3).

Main city and older districts

As might be expected in a case of rapid growth and urban sprawl, the different origins and time factors proved to be important in the economic and social consolidation of each area of the city. Thus, the settlements located in the older districts of Maipú, San Bernardo, Renca and Puente Alto, which were adjoined to Santiago in the growth of the city since the 1960s, follow a different consolidation process to those located in the new peripheral districts that grew from nothing. The analysis showed that it was not only a question of time, but that the inhabitants themselves had different social characteristics, used space in a different way and had a different subjective valuation of their habitat.

The older district settlements are characterised as having more families with both parents, incorporating married children and/or grandchildren in their household (composed nuclear families) with stable but low income (almost half of them are in manual labour, or dependant workers). The main city settlements have smaller, younger families, with a tendency to include other relatives in the household (extensive families). Although there are higher gross income levels in the older districts, the income per capita rate is virtually the same.

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Regarding their subjective valuations, the inhabitants of the older district settlements are significantly more satisfied with their residential situation (housing, neighbourhood, community) than those in the main city districts. And regarding movement patterns, the older district settlements have more vehicular movement in streets, while the movement patterns in the alleyways are virtually the same in both locations. Lastly, intelligibility and synergy were found to be higher in the older districts than in the main city settlements, thus showing a better embedment in the urban grid.

These differences are important to understand when interpreting the consolidation process in both locations. In line with the argument set forward during the EU stage of the project, the consolidation process in both locations was found to be set in motion by the movement economy: development of commercial activity, related to vehicular movement patterns in streets, that in turn are a product of the configuration of the urban grid. Nevertheless, different aspects were found to be setting the process in motion, and a "gridlock" between the housing and community aspects seemed to be drawing the development process to a halt, or at least reducing it considerably.

This gridlock refers to contradictions in the consolidation process: the data shows that community development and in particular satisfaction with the community is a prior requirement for housing development (Table 3); yet, while community develops more strongly under scarce social and economic resources (Table 2), housing development requires them (Table 3). The first is explained as a survival strategy of the weaker groups and the second as the importance of the family's socio-economic resources to invest in the house.

To a certain extent a vicious circle is created: the lack of social and economic resources helps to create a strong community where families help each other. Through their work and efforts, the families build their houses investing almost all their resources in them. The families that manage to improve their house considerably resent those that have not and start aspiring to leave the settlement for another one higher on the social scale. They either stop investing, or abandon the place leaving another poor family in the settlement to start the cycle again.

This vicious circle is to a certain extent broken in the older districts due to the subjective attachment that the families have with the place. These families have been in this area for more than one generation and although they inhabit practically the same or poorer housing conditions, they are in fact much more satisfied with their residential condition. In this way, they will keep on investing in their houses.

On the other hand, if higher community valuation stimulated the main city inhabitants to invest in their houses, in the older districts this is achieved by a better infrastructure (see Table 3). Probably due to the lower neighbourhood standards in older districts, it is an aspect highly valued and directly linked to the housing consolidation process.

Theoretical, Methodological and Policy Aspects

Having started from a simple question "Have spatial factors affected the differing degrees of consolidation of the peripheral settlements in Santiago de Chile?" the aim of this research was to contribute towards answering questions that have no simple answers: do spatial factors affect the physical and social development? Does it matter how cities are designed? Is space important?

The answer to the first question was answered positively, and the answers to the following questions are beyond the scope of the work presented here. Nevertheless this research contributes in that direction in three realms: theoretical, methodological and policy.

Theoretical aspects

In the theoretical realm the research detected several ways in which spatial configuration was involved in the consolidation process. At city level, the economic consolidation of local authorities was found to relate to the mean integration values. At settlements level, the research demonstrated that spatial variables and specifically configurational properties of the urban grid, have an important impact on the further development of housing settlements of poor sectors. It also demonstrates that it is not an 'either or' situation; urban consolidation is a complex process where social, economic, spatial and probably other variables according to specific cases, have important roles to fulfil.

The most important theoretical result is the association proposed between social development and local informal economic activity, the relation this has to local vehicular movement, and the relation this has in turn to local spatial design. These results are in line with other studies of the evolution of European cities. In particular, the 'movement economy' theory argues that in the growth of cities, spatial factors first influence movement patterns, and these then affect land use distributions (in that movement sensitive land uses move towards certain lines and locations). This then produces multiplier effects on movement, which then attract a great concentration of movement-dependent land uses. Over time, the whole process gives rise to the characteristic pattern of European cities with their intensive pockets of mixed use activity distributed within larger areas of less intense, mostly residential

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development. A comparable process seems to be under way in Santiago, and this must hold out much promise for the future both of these settlements and for this type of government initiative.

Methodological aspects

On the methodology side, the building of appropriate and reliable tools opened the possibility of comparing social and economic variables in a wide range of settlements located in different sectors of a big city. In this realm, the contribution is twofold: it includes the design proposition for building social and physical consolidation tools and the proposed way of modelling parts of complex urban systems.

The consolidation indices are important contributions, to be understood not as absolutely finished tools, but as examples of how to approach elusive social and community aspects. The work demonstrated the feasibility of using these tools to compare and quantify multivariable situations, but also suggested that the tools should be designed specifically for each novel situation. In fact, it is not a measuring tape and probably does not resist travelling from one cultural situation to another

The different ways of modelling the city and its analysis demonstrates that Santiago works both as one monolithic system and as partial systems. The parts of the city models are important contributions and demonstrate that different inhabitants in one complex system –such as a city of five million inhabitants perceive, live and use different spatial systems.

At city level, the traditional socio-economic segregation of Santiago is spatially understood in a part of the city model that directly mirrors the land and space use of the rich '*Oriente'* sector. At settlements level, the parts of the city models suggest that the inhabitants of the new periphery (or 'main city settlements') do not include the even more peripheral settlements –located in the older districts– in the urban system they live in and understand. Probably this is another aspect that subjectively enhances their marginal condition. On the other hand, the inhabitants of the older districts understand their urban system as a pie-section segment that extends from their particular location to the central CBD of the city.

Policy and planning aspects

The previous findings suggest some very specific recommendations for the spatial location and planning of future settlements and the adaptation of existing ones. They show that vehicular movement plays a critical role in the informal economy of poor settlements through supporting informal shops and thus allowing income from surrounding areas to be drawn into the settlement. Therefore, at least for lower income groups, the attempt to isolate homes from movement thoroughfares needs to be critically re-examined, since for these groups movement is a resource.

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Also, the results of the study show that mixed use, in particular informal shops, should be allowed and even encouraged. Since the informal settlements today will be the established districts of the future, the informal shops may presage the location of a neighbourhood shopping street in the future. Therefore, the location and layout of the settlements should ensure a degree of spatial integration into the urban context to allow the positive developmental process that has been identified.

But more important is that in a more general overview the results show that planning should be understood as the nurturing of an organic process, requiring ever improving understanding of these processes and feedback from interventions. The words of Koolhaas and Mau (1995) fully coincide with the results of the study:

" If there is to be a 'new urbanism' it will not be based on the twin fantasies of order and omnipotence; it will be the staging of uncertainty; it will no longer be concerned with the arrangement of more or less permanent objects but with the irrigation of territories with potential; it will no longer aim for stable configurations but for the creation of enabling fields that accommodate processes that refused to be crystallized into definitive form; it will no longer be about meticulous definition, the imposition of limits, but about expanding notions, denying boundaries, not about separating and identifying entities, but about discovering unnameable hybrids; it will no longer be obsessed with the city but with the manipulation of infrastructure for endless intensifications and diversifications, shortcuts and redistributions – the reinvention of psychological space."

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For the transformation of what today is a poor, undifferentiated and flat periphery, into a rich urban space where multiple and varied people and activities meet, the way to follow is precisely "the irrigation of territories with potential".

In this same line Busquets (1996) advocates the rebirth of an 'urban urbanism' and 'urban architecture' which recognizes the physical dimension of the urban project. He relates this to the emphasis on the value of public space as the privileged urban space.

Finally, in the policy and planning realm, the work done demonstrates an additional aspect that it did not originally intend to question: the effect of providing infrastructure and services in the social and physical consolidation of poor residential areas. Although the sample was chosen from settlements where the Neighbourhood Upgrading Programme had been implemented, and therefore presented similar infrastructure conditions, it became necessary to consider it as a variable affecting

the consolidation process in order to explain what has been happening in the periphery of Santiago. It therefore demonstrated, once more, the enormous impact of this sort of governmental action over poverty alleviation.

In summary, the research suggests that proper design of the urban grid could enhance the development of intensive pockets of mixed use activity distributed within quiet residential areas. This sort of development would not only give urban form, support and structure to what is now a vast and shapeless periphery, therefore affecting the quality of life of all the city's inhabitants, but at settlement level it would also attract economic resources from the neighbouring areas, sustain a natural street life and help to develop higher levels of satisfaction with the community. This would at last bring physical and social consolidation to the settlements. To support this 'movement economy' virtuous circle it is important to support the community ties in the case of the main city settlements, and to supply them with enough infrastructure in the case of the older districts.

Notes

[1] The work was initially developed as part of a joint research project between University College London and the Pontificia Universidad Católica de Chile, with funding from the European Union (EU) programme for collaborative projects between universities and developing countries. This was followed up by the author's PhD thesis (Greene, 2002).

[2] From the now traditional works of Turner (1976) and Fathy (1973), through Hardoy and Satterwaite (1987), Mac Donald (1987) and Gilbert (1986), to the more recent work of Marcuse, (1992), Greene at al (1992; 1997), Fiori (2001) and Brakarz et al (2002).

[3] The four planning interventions correspond to Benjamín Vicuña Mackenna in 1875, Karl Brunner in 1935, Plan Regulador Intercomunal de Santiago (PRIS) in 1960 and the Plan Regulador Metropolitano para Santiago (PRMS) in 1994. For further details see Greene (2002).

[4] The number of cases (17) was an impediment for disaggregating the data into 'main city' and 'older districts' when analysing the consolidation at settlements level, since multiple regressions with such a reduced number of cases (10 and 7) are known to be misleading. At family level there are 434 cases, 266 in the main city and 168 in the older districts, which allow for valid multiple regression exercises.

[5] Local spatial advantage or LSA is a compound syntactic variable designed in the EU stage of the project. It is calculated by taking the radius-n integration value of each settlement in the context of the 7 km^2 local system and dividing it into the mean integration value of the whole 7 km^2 system. The higher the value, the more the settlement has a higher integration relative to a comparable metric context. It can be understood as expressing the degree to which a settlement occupies a strategic position in its contextual area – hence 'local spatial advantage.

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