Original and converted social housing:
Spatial configurations and residents' attitudes

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Abstract
This paper explores how converted social housing has been spatially configured and what effect this has had on residents' attitudes. Conversions carried out in the original plans of a sample of 35 two bedroom detached houses in Vila Farrapos housing estate, in Porto Alegre, Brazil, constitute the field work. These houses were built and occupied during the sixties as part of the housing policy followed by the National Housing Bank, till the eighties when it was wound up. Space syntax techniques are used to measure configurational properties such as integration values, in addition to the statistical analysis of residents' attitudes concerning the original and converted plans. Private open spaces are considered as part of the spatial configuration of each house, as these spaces connect different internal spaces. Distinct spatial configurations affecting movement and choice of route are revealed, as well as the importance of open spaces as part of the configuration, and residents' attitudes towards the converted houses.

Keywords
converted social housing, spatial configurations, residents' attitudes

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Introduction

Houses can be understood as patterns of organised space, structured according to some social principles, which affect the size, connections and configuration of rooms, and the relationship between inhabitants and between inhabitants and visitors: "Houses can carry cultural information in their material form and space configuration ... It is proposed that the analysis of domestic space configuration provides the link between the design of dwellings and their social consequences... Integration has emerged in empirical studies as one of the fundamental ways in which houses convey culture through their configurations" (Hanson, 1998: 1, 32).

Social housing generally means housing for those less well off in society. In Brazil, where the research for this paper has been carried out, social housing has been, generally, financed by local, state or federal government and the housing units sold to low-middle income people. Those in the bottom of socio-economic scale are in the shanty towns and cannot afford to pay for the so called “social housing”. Those who can afford a “social housing unit” are accustomed to make conversions or modifications.

As referred to by Hanson (1998) houses may increase or decrease in size in a cyclical pattern according to an increase or decrease of household size, affecting the use of rooms. Moreover, an increase in the level of social and political complexity in society appears to be related to an increase in the partitioning of spatial configuration (Hanson, 1998). An increase in dwelling size has been a common practice involving social housing conversions in southern Brazil, affecting not only the original use of rooms, but also the original use of private open spaces (i.e. Reis, 2000, 1992). Since much of this converted social housing tends to have strong connections between the internal and external spaces, the private open spaces of each dwelling might be considered as part of the spatial configuration. Hanson has pointed out that: “Most studies of houses which are concerned with the relation among the interior spaces do not differentiate the grounds in which the house is located into their constituent spaces but there may be circumstances when it is essential to do so. Several studies in recent years have paid particular attention to modelling the complexity of external space, looking at the relationship between the house and its plot, the interface between the house and the street... It is quite common for the front-back orientation of the house to be associated with the public and private spheres of domestic life, express formal and informal social relations, provide appropriate settings for more ceremonial or more everyday, practical activities...” (Hanson, 1998: 280).

Investigation about residents’ attitudes concerning their houses produces knowledge about the effect of spatial configurations on their daily lives. Many studies have investigated, for quite some time, the relationship between the housing environment and residents’ attitudes and behaviour (e.g. Lay, 1992; Reis, 1992; Francescato et al., 1987). Nonetheless, the association between syntactic descriptions of spatial configurations and the resulting effects on users of these spaces is more recent. Hanson acknowledges that: “...it may be informative to ask people...about how they feel about their houses, whether they are satisfied with their homes and what further improvements they would like to make to the interior...” (Hanson, 1998: 306). Hence the objective of this paper is to explore how converted social housing has been spatially configured and what effect this has had on residents’ attitudes in a group of dwelling units in southern Brazil.

2. Methodology

Patterns of spatial transformations in detached houses were categorised according to the type of increase in size of the dwelling: 1) original house, 2) original house plus isolated extensions in the backyard, 3) 1 storey modified house with no isolated extensions in the backyard, 4) 1 storey modified house with isolated extensions in the backyard, 5) 2 storey modified house with no isolated extensions in the backyard and 6) 2 storey modified house with isolated extensions in the backyard. Modified houses were those characterised by an increase in the original dwelling size. Minor modifications such as adding the service area to the kitchen, closing the service area, using the loft as a store, removing partition walls, having terraces or underground garages were not considered as spatial transformations for the purpose of this paper. The results presented were obtained from the analysis of the original plans and of the data obtained from the field work conducted in a sample of 35 two bedroom detached houses in Vila Farrapos housing estate. These housing estates are located in Porto Alegre, Brazil, and were built for low-middle income people, as part of the housing policy followed by the BNH (National Housing Bank) from 1964 till 1986 when it was terminated. The Vila Farrapos estate was first occupied between 1965 and 1967. Data collection was made by means of physical measurements, questionnaires and informal interviews. Questionnaires were supplied to the residents of these dwellings with the objective of measuring attitudes and behaviour towards the dwelling and the private open spaces.

The predominant pattern of spatial transformations according to increase in dwelling size are the 22 modified houses with no isolated extensions in the backyard (Table 1). Other patterns of houses in Vila Farrapos include: 2 original houses, 2 original houses with isolated extensions in the backyard, 4 modified houses with isolated extensions in the backyard, and 5 two stories modified houses with no isolated extensions in the backyard.

Syntactic analysis is used to reveal the configurational properties of these 22 houses and of the original house plan. Spatialist, a software programme for spatial analysis developed at Georgia Institute of Technology, by John Peponis et al. (1997; 1998a, 1998b), is used to perform analysis of the plans of the housing selected for this study. An important configurational property is integration: a measure of the minimum number of intervening spaces that must be crossed in order to reach all spaces in the spatial configuration. An integrated space in the house allows more direct access to the rest of the house than a less integrated space (Peponis et al., 1998b; Hillier, 1996; Hillier and Hanson, 1984). As remarked by Hanson (1998: 32) “Integration has emerged in empirical studies as one of the fundamental ways in which houses convey culture through their configuration”. The pattern of connections between spaces can be represented as a justified permeability graph (Figure 1).

40.4

MAIN BUILDING																						
n°.	v	l	b	c	ba	k	d	kd	sl	la	de	brc	w	brd	lk	ha	bs	bar	gr	bki	g	total spaces
22 modified houses with no isolated extensions in the backyard - Vila Farrapos																						
1		1	2		1	1	1				1										1	8
2			1		2	1	1				1		1									7
3		1	3		2	1	1			1					1							10
4			4		3	1	1	1			1					1						12
5		2	2	1	1	1					1	1										9
8		1	3	1	2	2					1	1										11
9		2	2		1	1			1		1											8
10		1	3		2	2			1									1	1			11
11	1		3	1	2	1	1				1						1				1	12
14		2	1	1	1	1					1										1	8
16		1	2		2	1	1						1	1							1	10
17		2	4	1	2	2																11
21		1	3	1	1	1	1			1		1										10
22		1	2		1	1				1	1											7
23		2	2		2	2																8
24		1	2		1	1	1			1												7
26		2	1		2	1														1	1	8
27		1	2		2	1	1			1											1	9
28		2	2	1	2	1				1	1	1										11
30		1	3	1	1	1	1				1										1	10
33	1	1	3	1	1	1	1														1	10
34		1	4		2	2	1				1											11
t	2	26	54	9	36	27	12	1	2	6	12	4	2	1	1	1	1	1	1	1	8	208

Table 1: Predominant patterns of spatial transformations in 2 bed-room houses VF

note: t=total, not considering external open spaces; v= veranda, l= living-room, b=bedroom, c= circulation, ba= bathroom, k= kitchen, d=dining-room, kd=kitchen/dining-room, kbr= kitchen/barbecue room, sl= covered service area/ laundry, ug=underground garage, o=office, de= deposit, br= barbecue room, la=laundry, g=garage, o= others, brc = barbecue room/covered area, w= workshop, brd= barbecue room/deposit, lk= living room/kitchen, ha= hairdresser, bs= barber shop, gr= games room, bki= bedroom/kitchen

The Spatialist programme outputs real integration values, where the measure is adjusted to take into account the number of elements involved in the system, so that values across systems of different sizes can be compared, such as those representing the 22 modified houses and the original house plans in Vila Farrapos. These real integration values can be obtained by analysing the s-spaces. These convex analyses, however, can produce spaces which do not correspond to clearly defined rooms, not even to spaces clearly bounded by wall surfaces. When this situation happened in the analysis, we minimised the creation of spaces which might not correspond to the perceived spatial partition by eliminating some reflex corners and adopting a one line partition of spaces instead of the two lines produced by a reflex corner, which might fragment an otherwise unified interior space.

Accepting that "…topologically different types of space have quite different potentials for occupation and movement", "…the spaces that make up the justified permeability graph can be divided into four topological types" (Hillier, 1996: 318-319):

1. a type spaces: spaces with a single link; dead-end spaces through which no movement is possible to other spaces.

2. b type spaces: spaces with more than one link; movement through a b-type space to a neighbour must return to the origin through the same space; control movement strongly.

3. c type spaces: spaces with more than one link; movement through a c-type space to a neighbour need not return through the same neighbour but must return through exactly one other neighbour

4. d type spaces: "…spaces with more than two links and which form part of complexes which contain neither a- nor b-type spaces, and which therefore must contain at least two rings which have at least one space in common…"; "Movement from d-type spaces through a neighbour has the choice of returning by way of more than one other neighbour"; much less built-in control (Hillier, 1996: 319, 320, 323). Hence, b-type (the most constraining) and to a lesser extent c-type spaces control movement in a much stronger way than either a-type (does not allow for through movement) or d-type spaces (allows choice of movement) because they permit but at the same time constrain movement by requiring the inhabitant or the visitor to pass through specific sequences of spaces.

These topologically distinct types of space have quite different potentials for occupation and movement (Hillier, 1996). This division of the spaces that make up the graph into four topological types is used to illustrate the property of choice and depth in the 22 houses examined through their justified graphs.

3. Results and discussion

The analysis of the justified graph of the original and the 22 modified houses in Vila Farrapos, reveals that original house is a topological d-type complex (2 rings), and that 63% (14) out of 22 modified VF houses are c-type complexes (1 ring) including the external private spaces as part of the dwelling system (Tables 2 and 3, Figure 1). Moreover, 18% (4 out of 22) are b-type complexes and 18% (4 out of 22) of the houses are d-type complexes (2 rings). Houses 10 and 26 are, each, constituted by two independent b-type complexes, which are permeable to the public space of the sidewalk The topological categorisation of spaces reveals distinct levels of control and choice of route as previously stated. The houses are presented according to this categorisation, trying to answer the following question: how far do the 22 modified houses follow the spatial configuration of the original house? It is already revealed that only 18% of the inhabited houses followed the loose control of the original house topological organisation of d-type spaces. The other 82% spatial configurations are either characterised by b-type (18%) or c-type (63%) complexes, establishing a higher control of movement in the house system of internal and external spaces (Figure 1, Tables 2 and 3).

The rank order of real integration values for each Vila Farrapos house reveals how integrated each space is, by comparison with other spaces in the same house (Tables 2 and 3). Which are the spaces in the integration core? Is the integration core a deep or shallow core? In the original Vila Farrapos house the relatively shallow integration core is formed by a social space - the living room (3 and 11, the most integrated convex spaces), by an external space - a sideyard (2) and by a service space - the kitchen (10). The two bedrooms (5 and 9) are the most segregated spaces, followed by the other sideyard and by the backyard. Hence, one of the sideyards is more integrated in the complex than the frontyard, indicating its role in controlling access to the house. There is no transition space.

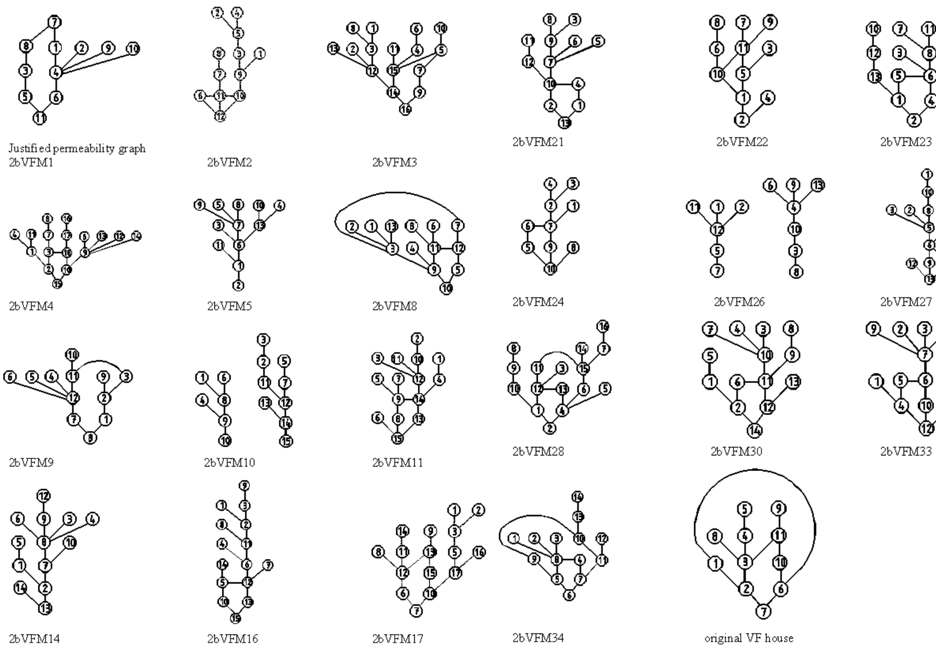

Figure 1: Justified permeability graph for the original and the 22 modified VF houses

Table 2: Rank order of real integration values for d-type and b-type house complexes

house	order of real integration values – integration core in bold – depth from the frontyard (light grey = shallow, dark grey = deep)	
Original house with no isolated extensions in the backyard		
spaces type	a a d a c c b c d c c	
Ori2bVF	b b sy ba fy by wb k sy li1 li1	relatively deep integration core
d-type	5 < 9 < 6 = 8 < 7 = 1 < 4 < 10 < 2 = 11 < 3	li1 (3)-strong control over movement
	0.577 0.698 0.829 0.829 0.885 0.885 0.948 1.021 1.327 1.327 1.896	
Modified house with no isolated extensions in the backyard – 4 d-type houses complexes		
spaces type	a a a c b a b d b d b d	
2bVFM2	ba ba d sy w1 by b fy kdi w1 sy1 sy1	relatively shallow integration core
d-type	8 < 2 = 4 < 6 < 7 < 1 = 5 < 12 < 3 < 11 < 9 = 10	sy1 - strong control over movement
2 rings	0.448 0.461 0.461 0.603 0.627 0.653 0.653 0.825 0.871 0.922 1.119 1.119	
spaces type	a a a a a c a c c d c c d	
2bVFM8	b ba b kb d t ba fy bp k li by sy	relatively deep integration core
d-type	6 = 8 < 1 < 2 = 13 < 5 < 4 < 10 < 7 < 12 < 11 < 3 < 9	
2 rings	0.827 0.827 0.866 0.866 0.866 0.909 0.957 1.137 1.299 1.399 1.653 1.819 2.273	
spaces type	a a b a a a b b c c c c c c d d	
2bVFM28	ba b1 d1 ba la li d1 b1 b k t fy li1 sybp sy l1	rel. shallow int. core
d-type	8 < 16 < 9 < 14 < 5 < 3 < 10 < 7 < 6 = 13 = 15 < 2 = 11 < 1 < 4 < 12	sybp, sy, b – strong
2 rings	0.447 0.573 0.586 0.676 0.753 0.775 0.799 0.824 1.054 1.054 1.054 1.098 1.098 1.146 1.255 1.318	control over mov.
spaces type	a a a a a b c c c c c d c d	
2bVFM34	b ba b b ba b fybp k1 k d di kl li sy	rel. shallow int. core
d-type	14 < 12 < 1 = 2 = 3 = 13 < 6 < 4 = 10 = 11 < 9 < 7 = 8 < 5	
2 rings	0.508 0.671 0.718 0.718 0.718 0.718 0.991 1.095 1095 1.095 1.156 1.224 1.224 1.301	
Modified house with no isolated extensions in the backyard – 4 b-type houses complexes		
spaces type	b a a a a a a a b b b b	
2bVFM5	fy k1 bp d b b ba li sy k1 t l	relatively deep integration core
b-type	2 = 4 = 10 = 11 < 5 = 8 = 9 < 3 < 1 =13 < 7 < 6	li-strong control over movement
tree-like	0.681 0.681 0.681 0.681 0.746 0.746 0.746 0.922 1.205 1.205 1.424 2.238	
spaces type	a a a b a a a b b b b b b b b	
2bVFM10	nl ba b sy b ba k gr b1 t b1 k li t bar	rel. shallow integration core
b-type	3 < 5 < 13 = 15 < 1 = 4 = 6 = 10 < 2 < 7 < 11 = 14 < 12 < 8 = 9	li-strong control over movement
tree-like	0.422 0.493 0.554 0.554 0.582 0.582 0.582 0.582 0.634 0.806 0.986 0.986 1.478 1.745 1.745	
spaces type	a a a b a a a b a b b b b	
2bVFM14	bp g ba1 by li b d fy k ba1 sy t l	relatively deep integration core
b-type	5 = 14 < 12 < 1 = 3 = 4 = 6 = 13 < 10 < 9 < 2 < 8 < 7	l i and t - strong control over mov.
tree-like	0.520 0.520 0.551 0.758 0.758 0.758 0.758 0.758 0.791 0.827 1.212 1.399 1.515	
spaces type	b b a a a a a a b b b b b	
2bVFM26	fy g li1 b ba kb ba by sy sy k li1 l	rel. shallow and rel. deep integration core
b-type	8 < 7 < 6 = 9 = 13 < 1 = 2 = 11 < 3 < 5 < 10 < 4 < 12	(systems 1 and 2) - strong control over mov.
tree-like	0.425 0.499 0.637 0.637 0.637 0.698 0.698 0.698 0.728 1.163 1.274 1.698 3.490	

A living room is also the most integrated space in 7 out of 22 houses investigated in Vila Farrapos; in 9 houses it occupies between the second and third place in the descending rank order of integration values. This shows the clear tendency for the social space of the living room to be kept as the space with the higher or one of the highest control over movement in the house, characterising the integration core of the house. On the other hand, in only 2 houses is a bedroom the most segregated space and in 4 the second most segregated space. The kitchen does not have a clear or consistent pattern of integration across the 22 houses. Transition spaces exist in 54% (12 out of the 22) of the houses. Therefore, around half of the houses grew up without having a transition space, as in the original house. When it existed, it clearly tended to be more integrated than segregated in the house (Tables 2 and 3).

house	order of real integration values – integration core in bold – depth from the frontyard (light grey = shallow, dark grey = deep)	
Modified house with no isolated extensions in the backyard – 14 c-type houses complexes		
spaces type	c a c c a a c c c c c	
2bVFM1	sy b g by ba d di fy k b li	relatively deep integration core
c-type	3 < 2 = 5 = 8 = 9 = 10 < 7 = 11 < 1 = 6 < 4	li-strong control over movement
ring	0.632 0.737 0.737 0.737 0.737 0.737 0.885 0.885 1.106 1.106 1.475	
spaces type	a a a a c a c a a b b c b c c	
2bVFM3	by1 ba la b k b di b b by1 wb li1 kli li1 sy	rel. shallow integration core
c-type	1 = 6 = 8 < 10 < 7 < 2 = 9 = 13 < 11 < 3 = 4 < 5 < 12 < 15 < 14	sy - strong control over mov.
ring	0.586 0.586 0.586 0.643 0.712 0.753 0.753 0.753 0.799 0.850 0.850 0.976 1.255 1.387 1.551	
spaces type	a a a a a a a a b b b b c c c c c	
2bVFM4	ba ba b b ba hd1 b d wb kdi di hd1 sy fy b k sy	shallow int. core = ring
c-type	8 < 4 = 11 < 16 < 6 = 13 < 12 = 14 < 7 < 1 < 17 < 9 < 2 = 15 < 3 < 18 < 10	sy(10,2) – strong control over mov.
ring	0.552 0.563 0.563 0.574 0.665 0.665 0.681 0.681 0.770 0.791 0.813 1.009 1.126 1.126 1.171 1.273 1.331	
spaces type	a a a a a c c c c c c c	
2bVFM9	d b ba li b sy la fy k sy t li	relatively deep integration core
c-type	9 < 10 < 4 = 5 = 6 < 1 < 2 = 8 < 3 = 7 < 11 < 12	li-strong control over movement
ring	0.580 0.746 0.783 0.783 0.783 0.825 0.922 0.922 1.119 1.119 1.424 1.567	
spaces type	a a a a a a a b b c b c c b c	
2bVFM11	k d ba b ba b b di fyvg bs1 t1 sy bs1 t1 t1	rel. deep integration core
c-type	2 < 6 = 1 < 3 = 5 = 7 = 11 < 10 < 15 < 8 < 4 < 13 < 9 = 12 < 14	t1 (14,12) - strong control over mov.
ring	0.574 0.604 0.654 0.785 0.785 0.785 0.785 0.841 0.905 0.942 1.023 1.177 1.385 1.385 1.962	
spaces type	a a b a c c a a b c c b a b c	
2bVFM16	by ba t b fyg sy ba b dbp li k di1 d1 wb wr	rel. deep integration core
c-type	9 < 1 < 3 < 14 < 15 = 10 < 4 < 7 < 2 < 13 < 5 < 11 < 8 < 6 < 12	wr– strong control over mov.
ring	0.453 0.574 0.604 0.619 0.654 0.673 0.759 0.785 0.841 0.872 0.942 1.121 1.177 1.308 1.385	
spaces type	a a a b a b a a b c c c c b c c	
2bVFM17	ba b ba t b wb b b k li1 sy fy li1 li k sy	rel. shallow int. core
c-type	1 = 2 < 14 < 3 = 8 < 11 < 9 = 16 < 5 < 12 < 6 < 7 = 13 = 17 < 15 < 10	sy and li - strong control over mov.
ring	0.425 0.425 0.439 0.549 0.549 0.573 0.599 0.599 0.694 0.775 0.824 0.879 0.879 0.879 0.941 1.014	
spaces type	a a a c c a a b c c b b c	
2bVFM21	sy ba b k1 fy b b bp li k1 la t di	rel. deep integration core
c-type	11 < 3 = 8 < 1 = 13 < 5 = 6 < 12 < 2 = 4 = 9 < 7 < 10	di and t - strong control over mov.
ring	0.606 0.627 0.627 0.699 0.699 0.827 0.827 0.957 1.010 1.010 1.010 1.653 1.819	
spaces type	a a a a a b b c c c c	
2bVFM22	sy d1 b ba b fy d1 li sy k labp	rel. deep integration core = ring
c-type	4 < 8 < 3 < 7 = 9 < 2 < 6 < 5 < 1 = 11 < 10	
ring	0.510 0.531 0.664 0.698 0.698 0.781 0.829 1.206 1.327 1.327 1.475	
spaces type	a a a b a b b c c c c c	
2bVFM23	ba ba b b li k li1 fy sybp sy k li1	shallow integration core
c-type	10 < 7 = 11 = 12 < 3 < 13 < 8 < 2 < 4 < 1 < 5 < 6	li1 and sy - strong control over mov.
ring	0.402 0.540 0.540 0.540 0.681 0.746 0.825 0.871 0.922 1.045 1.119 1.205	
spaces type	a a c a c c a c b c	
2bVFM24	la ba sy b fyv k sy li b di	rel. deep integration core
c-type	3 = 4 < 5 < 1 = 10 < 6 = 8 = 9 < 2 < 7	di - strong control over mov.
ring	0.688 0.688 0.846 0.917 0.917 1.222 1.222 1.222 1.375 2.750	
spaces type	a a a b c a a b b c c b c	
2bVFM27	ba sy la b fyg by ba k b sy li di1 di1	rel. deep integration core
c-type	1 < 12 < 4 < 10 < 13 < 2 = 3 < 7 < 8 < 9 = 11 < 5 < 6	di - strong control over mov.
ring	0.455 0.492 0.568 0.627 0.699 0.758 0.758 0.866 0.909 0.957 0.957 1.399 1.515	
spaces type	a a b a a a a b c c b c c c	
2bVFM30	d ba1 by b k sy b ba1 fyg sy di b li t	rel. shallow int. core
c-type	5 < 8 < 1 < 3 = 4 = 7 < 13 < 9 = 14 < 2 < 10 < 6 = 12 < 11	t - strong control over mov.
ring	0.484 0.612 0.671 0.694 0.694 0.694 0.718 0.946 0.946 0.991 1.156 1.224 1.224 1.734	
spaces type	a a a a a a c c c c b c	
2bVFM33	bybp b b ba b g sy fyg k li t di	rel. deep integration core
c-type	1 < 2 = 3 < 8 = 9 < 11 < 4 = 12 < 5 < 10 < 7 < 6	di and t - strong control over mov.
ring	0.580 0.746 0.746 0.746 0.746 0.783 0.922 0.922 1.119 1.205 1.424 1.741	

note: nl = no label, li= living room, b=bedroom, k=kitchen, di=dining room, kdi=k+di, kb=k+b, kli=k+li, ba= bathroom, wb=wash basin place, la=laundry, d=deposit, g=garage, bp=barbecue place, gbp=g+bp, labp=la+bp, dbp= d+ bp, labpd=la+bp+d, o=office, w=workshop, wbp=w+bp, wr=working room, bar= bar, gr=games room, hd=hairdresser, bs=barber shop, t=transition space, ca=covered area, v=veranda, fy= frontyard, fybp=fy+bp, fyg=fy+g, fyvg=fy+v+g, fyv=fy+v, sy= sideyard, sybp=sy+bp, syg=sy+g, by=backyard, bybp=by+bp, byla=by+la; numbers, ordered according to real integration values, represent convex spaces in specific rooms; a repetition of the same number indicates convex spaces belonging to the same room.

Table 3: Rank order of real integration values for c-type houses complexes

Integration values for the sideyard tend to follow the rank order of integration values for the sideyard of the original house, with one sideyard among the most integrated spaces and another among the most segregated. When there is only one sideyard, a tendency exists for it to be well integrated in the system of internal and external spaces (Tables 2 and 3). With exception of houses 5 and 26, where the frontyard is the most segregated space, it generally occupies a position not far from the middle, confirming the rank order of integration value for the frontyard in the original house. There are no backyards in 12 houses out of the 22; when they exist, their integration values vary in the rank order. Hence, in more than 50% of the houses, the backyard has been totally occupied by new internal spaces.

New activities and function spaces were added to the original houses, such as a dining room, a barbecue place, a store and a garage. A dining room was added to 12 houses, being on 4 occasions the most integrated space in the house. A barbecue place which is a cultural requirement in southern Brazil either as a specific room or as part of the exterior space where the activity of barbecue takes place, was created in 10 houses, varying from being the most integrated to the most segregated space. Of the total number of houses, 54% (12) had a store, generally more segregated in the system, being twice the most segregated space. A garage was added to 8 houses, varying in its integration.

A characteristic pattern of modified houses with no isolated extensions in the backyard in VF, considering the number and type of rooms, might be represented by 1 or 2 living rooms, 2 or 3 bedrooms, 1 or no circulation space, 1 or 2 bathrooms, 1 or 2 kitchens, 1 or no dining room, 1 or no store, 1 or no laundry, and 1 or no garage. The mean number of internal spaces is 9.45 spaces per house, varying from 7 to 12 spaces (Table 1). The main explanations for increase in dwelling size are: 50% (11) of residents bought already with all or some changes; 31.8% (7) said that the rooms were very small in the original house; 27.3% (6) mentioned an increase in family members; 13.6% (3) had a married son (daughter) living with them; and 9.1% (2) built rooms for working activities.

Integration core tends to be relatively shallow in the d-type houses, and relatively deep either in the b-type houses or in the c-type houses. The integration core tends to be constituted in both the d-type and b-type houses by a sideyard, a living room and a kitchen, and in the c-type houses by these spaces in addition to a dining room (Table 1, Figure1). Bedrooms and bathrooms tend to be the most segregated spaces in d-type houses. In the b-type houses, there is no consistent pattern, including for example, frontyard, barbecue place, bathroom, bedroom and garage. C-type houses, also do not present a more consistent pattern of segregated spaces, these including sideyard, bedroom, garage, backyard, laundry, bathroom, bedroom, living room, kitchen, deposit, and transition space.

An inequality genotype is a common patterns sequence in the rank order of integrations of key function spaces in the home. "To the extent that there are commonalities in the, then we can say that there is a common pattern to the way in which different functions are spatialised in the house" (Hillier, 1996: 36). Would the inequality genotype characterised by the original houses such as b < k < sy < li would hold for the 22 occupied and transformed houses in Vila Farrapos? In d-type houses it holds partially, with an inversion of living room and sideyard (li < sy) in 3 of the 4 houses. In b-type complexes, the integration value of the sideyard is smaller than that of the kitchen (sy < k) in 3 out of the 4 houses. In c-type houses, the following order of integration values are found: li<sy (1 house), k < b (2 houses), b<sy<k<li (2 houses), b<sy<li<k (1 house), b<li<k<sy (1 house), b<li<sy<k (1 house), sy<b<li<k (1 house), sy<b<k<li (1 house), k<sy<li<b (1 house), k<sy<b<li (1 house).

The extent of variability of integration values of different spaces in a single complex can be quantified by comparing the values of the most integrated and the most segregated spaces with the mean integration value for the complex (e.g. Hanson, 1998). The degree of differentiation among integration values is one of the means of showing how strongly social relations express themselves through space (Hillier et al., 1987). This can be expressed as a "difference factor", which measures how strongly or weakly a consistency is maintained within a spatial pattern, by calculating the degree of difference amongst the integration value of any three (or more, with a modified formula) spaces or functions in a complex (Orhun et al., 1995; Hillier et al., 1987). Hence, the difference factor measures the degree of configurational differentiation among integration values, revealing how far this differentiation between the integration values of any three or more spaces is consistent for a sample of houses.

The calculation of difference factor has been demonstrated elsewhere (e.g. Hanson, 1998; Hillier et al., 1987). The closer to 0 the difference factor, the more differentiated the spaces are and, the closer to 1 the more homogenised the spaces are with little configurational differences (e.g. Hanson, 1998). The difference factor (0.7282) shows that the original two bedroom house in Vila Farrapos has the less homogenised spatial configuration among the d-type complexes, being less homogenised than 14 out of the 22 modified houses (Table 4). The least spatially differentiated is a c-type house complex (2bVFM17, Table 4, Figure 2), and the most spatially differentiated is a b-type complex (2bVFM26, Table 4, Figure 2).

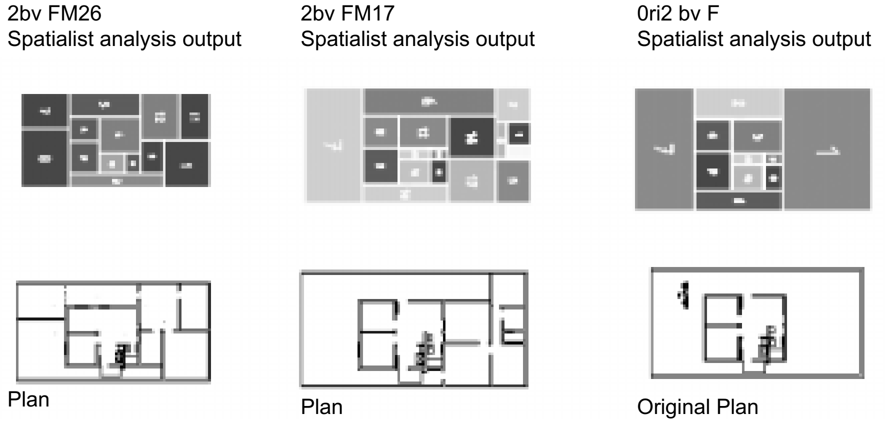

Figure 2: Spatialist analysis output and plan of original and converted houses 17 and 26

Which are the levels of depth of main functions (social, service, private) from the frontyard, where inhabitants and visitors enter the house? It might be argued that traditionally in the state of Rio Grande do Sul, the deeper cells of the configuration were occupied by the inhabitants and the shallower cells by inhabitants and visitors. In the original house in Vila Farrapos, the main living room space (3) is relatively shallow as is the kitchen (10), and the deepest a-type spaces are the two bedrooms (5 and 9). The deepest spaces in any of the three types of houses complexes are, with few exceptions, a-type spaces characterised frequently by bedrooms and bathrooms (Table 1, Figure 1). The shallowest spaces tend to be b-type in b-type houses complexes, c-type in c-type houses complexes, and d-type or c-type in d-type houses complexes, characterised mainly by external spaces in the 4 d-type houses complexes, and by a living room and external spaces either in the 4 b-type or in the 14 c-type houses complexes (Table 1, Figure1). The shallowest spaces tend to be the most integrated and the deepest, the most segregated.

Table 4: Integration values, mean depth, difference factor and topological type for each VF house

house	Mean depth	Integration considering the exterior			Difference factor	Topological
		mean	min	max		type b,c or d
Original house with no isolated extensions in the backyard						
Ori2bVF	2.436	1.020	0.577	1.896	0.7282	d
Modified house with no isolated extensions in the backyard – 22 houses						
2bVFM2	3.152	0.730	0.448	1.119	0.8392	d
2bVFM8	2.397	1.208	0.827	2.273	0.7830	d
2bVFM28	3.125	0.907	0.447	1.318	0.7923	d
2bVFM34	2.835	0.945	0.508	1.301	0.8385	d
2bVFM5	2.636	0.996	0.681	2.238	0.6880	b
2bVFM10	2.373	0.849	0.422	1.745	0.6301	b
2bVFM14	2.974	0.856	0.520	1.515	0.7756	b
2bVFM26	2.041	1.022	0.388	3.490	0.2200	b
2bVFM1	2.582	0.889	0.632	1.475	0.8491	c
2bVFM3	3.183	0.876	0.586	1.551	0.8044	c
2bVFM4	3.368	0.844	0.552	1.331	0.8464	c
2bVFM9	2.591	0.964	0.580	1.567	0.8099	c
2bVFM11	2.924	0.973	0.574	1.962	0.6999	c
2bVFM16	3.181	0.851	0.453	1.385	0.7711	c
2bVFM17	3.758	0.690	0.425	1.014	0.8557	c
2bVFM21	2.782	0.952	0.606	1.819	0.7529	c
2bVFM22	2.655	0.913	0.510	1.475	0.7896	c
2bVFM23	3.015	0.786	0.402	1.205	0.7837	c
2bVFM24	2.200	1.185	0.688	2.750	0.6123	c
2bVFM27	3.026	0.843	0.455	1.515	0.7297	c
2bVFM30	2.956	0.913	0.484	1.734	0.6957	c
2bVFM33	2.606	0.973	0.580	1.741	0.7642	c

Hence, d-type spaces might be understood as very important spaces in the overall configuration, and so are they reserved for important activities? In the original house, d-type spaces are the two sideyards (2 and 6); c-type spaces are the frontyard (7), the living room (characterised by 2 convex spaces, 3 and 11), and by the kitchen (10). D-type spaces include internal (a kitchen twice) and external spaces (always a sideyard) in the 4 d-type houses complexes. Generally, d-type spaces are, as in the original house, the shallowest and the most integrated spaces in the houses, revealing that this loose control is kept near to the public space of the sideyard (Table 1, Figure 1).

C-type spaces are, normally, part or near to the integration core either in the 4 d-type or in the 14 c-type houses complexes. Although, not frequently part of the shallowest spaces in these houses, c-type spaces rarely are among the deepest ones. C-type spaces are, in the 4 d-type houses: sideyard (1), sideyard / barbecue place (1), frontyard (2), frontyard / barbecue place (1), backyard (1), living room (3), kitchen (3), transition (2), barbecue place (1), bedroom (1), deposit (1), dining room (1). There is an equilibrium between the number of c-type and a-type spaces. C-type spaces are, in the 14 c-type houses: sideyard (16), sideyard / barbecue place (1), frontyard (6), frontyard / garage (3), frontyard / veranda (1), frontyard / veranda/ garage (1), backyard (1), living room (14), kitchen (12), dining room (6), transition (3), bedroom (3), garage (1), laundry (1), laundry / barbecue place (1), barber shop (2), working room (1). Again, there is equilibrium between the number of c-type and a-type spaces. Hence, the living room and the kitchen, as in the original house tend to be c-type spaces having a rather loose control over movement and allowing some choice of route (Tables 2 and 3, Figure 1).

More extensive rings are found in c-type houses 1, 3, 9 and 17, and in d-type houses 8, 28, 34, apart from the original one (d-type), with a living room and/or a sideyard, normally strongly controlling movement from and into the ring (Tables 2 and 3). The fact that 18 houses out of 22 are ringy houses, it might be argued that the clear majority of transformed houses are spatially configured in a way which supports social interaction, reflecting a culturally established frame of social relations, with the open spaces creating important connections between internal spaces. As pointed out by Hanson: “It is...possible to speculate that whilst tree-like houses normally support strongly framed social situations where access to and movement about the house need to be controlled in the interests of an individual inhabitant or group of residents, ringy houses usually support social situations where the dominant interface in the dwelling is between and individual host and his guests or between some group of residents in the house and their visitors” (Hanson, 1998: 279)

It is important, also, to look at the integration values of a function space across different houses, in order to check for their variability. The difference factor values reveal that the second sideyard (0,8634), followed by the kitchens (0,8518) and by the frontyard (0,8259) are the most configurationally stable spaces across the 22 transformed houses. The less stable or most configurationally differentiated spaces are the living rooms, followed by the backyards (Table 5).

function	No. of cases	Including exterior spaces			
		Mean integration	max	min	difference factor
Internal spaces					
living rooms	24	1,3176	3,490	0,758	0,5230
dining rooms	12	1,2897	2,750	0,753	0,6648
kitchens	30	0,9852	1,399	0,574	0,8518
bedrooms	54	0,7511	1,375	0,425	0,7364
barbecue places	10	0,9412	1,475	0,520	0,7990
External spaces					
Front yards	20	0,8561	1,137	0,425	0,8259
First side yard	22	1,1204	2,273	0,554	0,6355
Second side yard	11	0,7924	1,146	0,492	0,8634
Backyards	10	0,7977	1,819	0,453	0,6153

Table 5: Mean depth and integration for some functions of Vila Farrapos houses

note: when 2 convex spaces were part of the same room, the higher integration value was selected for calculating the mean integration value for that function space; no. of cases indicates the total number of that specific function space (in many houses, 1 function space was equal to 1 room) and not of convex spaces

How these patterns of spatial transformations and configurations affect residents' attitudes is revealed. Diseggregation of the data by space type complex has not been tried in this paper, but it might be useful in order to check how far different types of houses complexes might affect residents' attitudes toward their internal and external spaces. Positive feelings about the dwelling and about the rooms were expressed by 59.1% of respondents, while 31.8% were dissatisfied in both cases. A smaller percentage 54.5% was satisfied about internal dwelling layout, while 31.8% were dissatisfied. Feelings about accessibility from room to room were positive for 68.2% of residents and negative for 27.3%. Positive feelings about additions made (or not) to the dwelling were expressed by 72.7%, while 27.3% were dissatisfied.

The clear majority (81.8%) of those living in the modified two bedroom houses in Vila Farrapos agreed with the assertion about dwelling size being one of the biggest original problems. Moreover, 86.4% agreed that it was very important to be able to change dwelling size, 54.5% agreed with the assertion that would have made changes in any dwelling type, and half of residents still wished to add new rooms to the dwelling. On the other hand, 100% agreed that it would be much better if one did not have to make changes.

3.1 Private open spaces

The use of private open spaces are related to a number of factors: an almost lack of use of backyards for adults' recreation and growing vegetables, the use of side yards as a pedestrian way (59.1%) and for drying clothes (50%), followed by childrens' recreation (18.2%). Less than a half (40.9%) of those in Vila Farrapos used the backyard for drying clothes, the second activity being childrens' recreation (13.6%). The frontyard is mainly used for watching (72.7%), children (59.1%) and adult (36.4%) recreation. The reasons behind theses differences seems to be related to the small space left in the backyard of modified detached houses in Vila Farrapos, which prevented many activities being carried out. Feelings about the use given to the frontyard and feelings about the use given to the backyard were the same (54.5% sat. 45.5% dis.). Feelings about use given to the side yards are a bit more positive (68.2% sat.), although still revealing a fair percentage of dissatisfied residents (31,8%). In addition, more than a half (54.5%) of residents of modified houses in Vila Farrapos agree with the statement that "one of the biggest original problems was lot size" (136m2). Moreover, 63.6% wished to increase the size of the private open space.

4. Conclusion

This paper intended to explore how converted social housing has been spatially configured and what were the resulting residents' attitudes. The expressive majority of spatial configurations of converted houses exerted a higher control over movement and a restriction in choice of routes compared to the spatial configuration of the original house. Arising from this paper is a suspicion that some topologically distinct spatial configurations and connections were incorporated into the 22 converted Vila Farrapos houses, not because they were a natural consequence of intended social relations but because they were forced to build in such a way, due to the original plot and dwelling size and spatial configuration.

Residents' attitudes concerning the transformed houses with no isolated extensions in the backyard in Vila Farrapos, reveals negative feelings about the internal and external spaces. These appear to be related to extensive occupation of external spaces by internal spaces, which affected the type of use of external spaces and the quality of use of internal spaces. This quality was partially translated into the spatial configurations, where some functions were affected by the type of connections and relative position in the complex. Moreover, original dwelling size was a problem for residents, as was plot size. These feelings were clearly translated into the fact that the majority of those living in the 22 houses investigated in Vila Farrapos, would not like to live in a similar place, if moving. These results indicate that modifications by themselves do not, necessarily, result in attachment to place.

Further investigation is needed in order to establish relationships between specific spatial configurations and residents attitudes and behaviour. Visual privacy in the interior may be a major variable to be considered in the investigation of the system of spatial relations in the dwelling. The concepts of integration and segregation may be used to reveal distinct levels of privacy, as well as the concept of isovists from specific points in the dwelling.

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