Urban identity through quantifiable spatial attributes
Coherence and dispersion of local identity through the automated comparative analysis of building block plans

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This analysis investigates whether and to what degree quantifiable spatial attributes, as expressed in plan representations, can capture elements related to the experience of spatial identity. By combining different methods of shape and spatial analysis it attempts to quantify spatial attributes, predominantly derived from plans, in order to illustrate patterns of interrelations between spaces through an objective automated process. The study focuses on the scale of the urban block as the basic modular unit for the formation of urban configurations and the issue of spatial identity is perceived through consistency and differentiation within and amongst urban neighbourhoods.

Hypothesis and aims

Analytical decomposition: the city through the urban block

Focusing on the scale of the urban block as the module of urban agglomerations, the analysis attempts to reveal the degree and nature of relation between quantifiable scalar, geometrical and topological spatial attributes, as they are expressed through plans, with the identity of the corresponding spaces, experienced from the point of view of the dweller and the passerby.

The building blocks that compose five distinct urban neighbourhoods, four in Athens and one in London, are analysed using a set of methods for the measurement of plan features, which are then used for the classification of the neighbourhoods according to their experienced character.

The urban block is viewed as a configuration of built and open spaces whose geometrical shape and topological interrelations determine to a great extent the visual perception of urban environments, influencing spatial experience and defining local particularities related to spatial identity.

The notion of urban identity is examined by analysing patterns of relations amongst quantifiable spatial attributes as expressed in plan representations of the selected building blocks.

The main objective of the analysis is to investigate if and to what extent quantifiable attributes of spatial representations can provide information about spatial qualities that are non-discursive [1] but essential to the experience of spatial identity, in the sense that they are not easily described verbally or handled consciously, but intuitively and experientially perceived and manipulated during our daily existence in physical space.

The selection of neighbourhoods that are experientially recognisable as having particular, unlabelled qualities enables the examination of the hypothesis of correlation between our sense of spatial perception and the specific set of measurement methods.

Analytical recomposition: urban identity as a system of relations

“A city is a network of paths, which are topologically deformable” [2]. The city is viewed as a system whose identity constantly emerges from the rearrangement of interrelations between its elements. Focusing on the urban neighbourhood as a set of building blocks, this view on urban identity is tested through the automated identification of the structure of relations between discrete blocks of labelled neighbourhoods.

Attractions within urban locations, related to the consistency of the neighbourhood, are associated to spatial relations based on physical contiguity and continuity. Attractions amongst areas are related to transpatial relations [3] that act beyond spatial discontinuities.
The attempt to classify blocks according to a partial description of their attributes tests the possibility of discerning between sets of blocks that can, or cannot, coexist in the framework of a given neighbourhood. This would enable the illustration of an abstract synchronous view of the structure of relations from which urban identity emerges.

It is not the measured attributes per se that reveal elements of spatial identity, but the belief that they are governed by and reflect patterns in a structure of relations from which identity emerges, renders these attributes partial indices of degrees of differentiation and identification between spatial units.

However, the efficiency of these indices is limited and their interpretation ambiguous, since major issues concerning the formation and perception of spatial identity are not spatial or describable in spatial terms.

In this framework, the analysis is based on a series of reductions and concessions regarding the relation between urban identity and quantifiable attributes of spatial representations. Despite these limitations, it is believed that such attributes do account for the way in which the city is perceived and its identity experienced, reproduced and propagated through space and time.

Context and significance

The relation between quantifiable spatial attributes, inherent in plan representations, with the experience of space and spatial identity, has been in the centre of focus of a wide range of theoretical and practical investigations. Although the plan excludes aspects of our experience of space, a variety of multi-modal analyses exist that can be inferred from it.

These can be generally distinguished into spatial investigations concerning the potential connection between patterns of human behaviour and patterns of spatial constants within plan configurations and researches regarding the categorisation of spaces based on comparisons between quantified features of the corresponding plans.

In the first direction, space syntax has developed several methods for the analysis and quantification of configurational attributes in relation to spatial experience. Other closely related studies investigate the way in which the structure of space and movement affect our exposure to the elements of shape [4], [5], [6], [7].

In the second direction, methods that aim at the quantification of qualitative, semantic features of shapes enable the classification of building plans within a relative system of comparisons [8], [9]. Qualitative shape representations have been used for the categorisation of plans, based on degrees of similarities between their codified features and defined shape categories [10]. Methods of classification of building plans according to the quantification of spatial features deriving from axial and boundary maps have been implemented by Hanna both in an analytic and in a generative framework [11], [12].

This analysis doesn’t propose a new method for feature measurement but implements a combination of various, established and experimental methods, developed in the context of different strategies of spatial investigation, in order to determine which are necessary or best suited to classify urban areas with different experienced character.

Variability of methods aims at multileveled spatial descriptions while the possible overlapping of measurements contributes to the validation of the different approaches. The automation of measurement and evaluation processes enables the unmediated representation of a system of relations based on the equivalent consideration of different methods.

At this stage, the main aim is to investigate the suitability of the specific set of methods for distinguishing between urban areas. The study case is being used as a test sample of known, labelled neighbourhoods, in order to enable the evaluation of the degree of conversion between the classification resulting from the methods under examination and the pre-existing knowledge about the given areas. This could contribute to the understanding of spatial perception by designating categories of spatial features that seem to be relevant to our experience of space. The combination of these measurements with information about the cultural history of places could contribute to the understanding of the relationship between the physical output of cultures and possibly to the development of methods for designing within particular cultural contexts.

Methodology

The study case

The city of Athens, Greece, was selected as the main study case and four central neighbourhoods were analysed. The dataset was complemented by a neighbourhood in London, in order to examine the scope of the analysis (Figure 1).

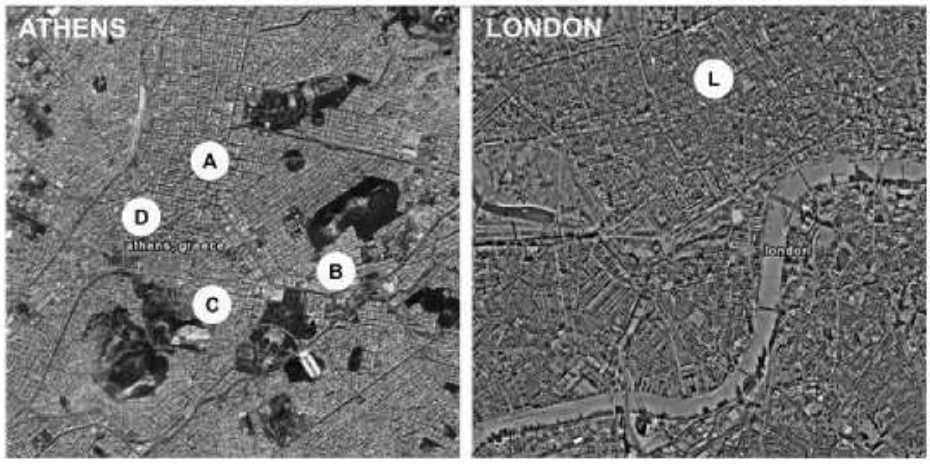


Fig. 1 The study case: five urban areas

The selected areas were Mouseio, Kolonaki, Plaka and Metaksourgeio in Athens and Bloomsbury-Fitzrovia in London (Figure 2).

Fig. 2 Characteristic snapshots of the selected areas. From left: Mouseio-Area A, Kolonaki-Area B, Plaka-Area C, Metaksourgeio-Area D, Bloomsbury-Area L

Mouseio, labelled as area A, is a very central and busy area, adjacent to Omonoia square, highly mixed in terms of national and social composition and characterised by predominantly modern constructions.

Kolonaki, registered as area B, is a neighbourhood on the banks of mount Lycabetus, also characterised by modern constructions. It is considered to be the traditional bourgeois area of central Athens.

Plaka, or area C, is part of the historical core of Athens, at the feet of the Acropolis. It is a protected area of cultural heritage, characterised by many archaeological sites and low rising buildings, prevailingly constructed before the beginnings of the twentieth century.

Metaksourgeio, labelled as area D, is an early-industrial area, situated along Peiraios avenue, the main connection between Athens and the port of Piraeus. It was developed in the nineteenth century in direct relation to the silk factory that was functioning in the area. The neighbourhood has been scarcely reconstructed.

Finally Bloomsbury, or area L, is a central neighbourhood of London, characterised by mixed land uses and variable construction phases.

The dataset consists of twenty-five building blocks from each area (Figure 3).

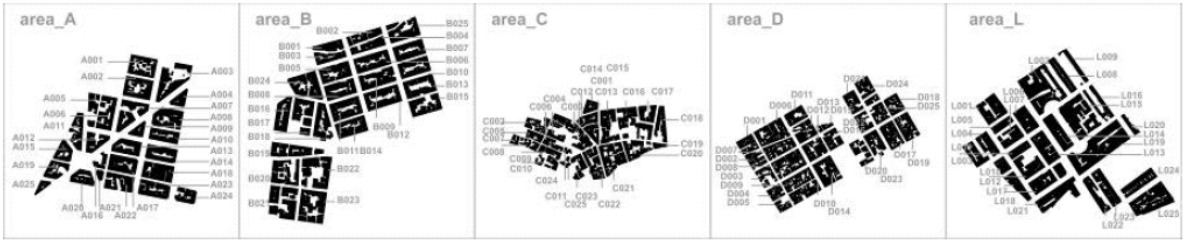


Fig. 3 The dataset: numbered building blocks

Measurement methods

A set of methods, used in distinct fields of spatial studies, were implemented in order to examine which are best suited to classify between the neighbourhoods.

Each of the methods produces measurements that capture different attributes of spatial configurations. According to the focus of each process, the quantities measured for the analysis of the blocks could be distinguished into scalar, geometrical and topological. This distinction shows that each method can only partially describe the plans. The comparative combination of measurements deriving from different methods enables a more complete, multiple consideration of the dataset and at the same time allows the examination of the suitability of the selected methods.

Scalar measures: Established measurements of Urbanism

Quantities involved in established urban analysis, such as footprints, floor area factors and number of buildings or voids per block, can be considered as scalar, since they don't describe geometrical or topological characteristics of the plans, but relations between quantities.

Geometrical measures: Fractal dimension through box-counting

Fractal dimension is a measure of dimensionality of fractal structures but in the case of architectural structures it refers to self-similarity and therefore to metric proportions of the parts in relation to the whole, reflecting geometrical attributes of space. The measurement of fractal dimension has been widely implemented by Bovill [13] in the context of various architectural analyses.

In this study, fractal dimension was used as an index of complexity and self similarity of the contours of open and built spaces. It was considered relevant to the perception of the blocks, since the amount and scale of meandering of the spaces constituting them affect the visual permeability of open spaces and the way they are perceived from the street or through the windows of adjacent buildings in terms of visual depth and layering.

The method used for the calculation of fractal dimension of the plans measures the box-counting dimension. This method, allowing the measurement of composite objects rather

than single fractal curves, enabled the calculation of the fractal dimension of each plan as a whole.

Practically, the box-counting method is based on a repetitive process of laying a grid of constantly decreasing scale over the image under measurement (Figure 4). At each grid scale, the number of cells that contain parts of the structure is counted and the fractal dimension is given by the comparison between scales.

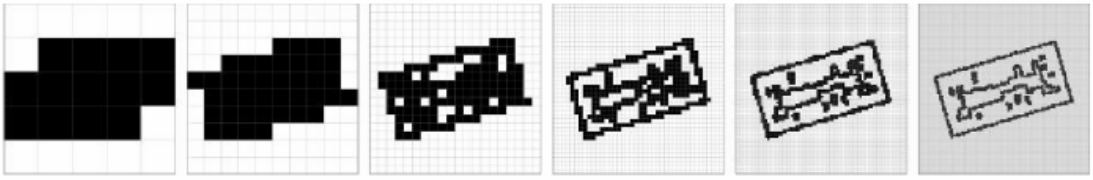


Fig. 4 Graphic calculation of box-counting dimension of a sample plan

Despite the drawbacks of this method, deriving from its sensitivity to issues of scale and its dependence upon the relation between the image under measurement and the grid, the appropriate graphic preparation of the plans can lead to rather consistent results.

Syntactic-topological measures: Spatial connectivity

Methods related to spatial connectivity [1], such as spectral analysis of axial graphs and convexity measurements of shape perimeters, focus on syntactic properties of the plans. Their results are affected both by the geometry and topology of the configurations under measurement, but what is measured is essentially the relation between locations of the plans, both at a local and at a global level. In this sense, these methods can be considered as prevailingly topological.

a. Classification by principal components analysis using axial graph spectra

Spatial representation and analysis through axial maps is used by space syntax in order to illustrate and quantify connectivity relations in continuous spaces, it terms of unobstructed sight lines (Figure 5).

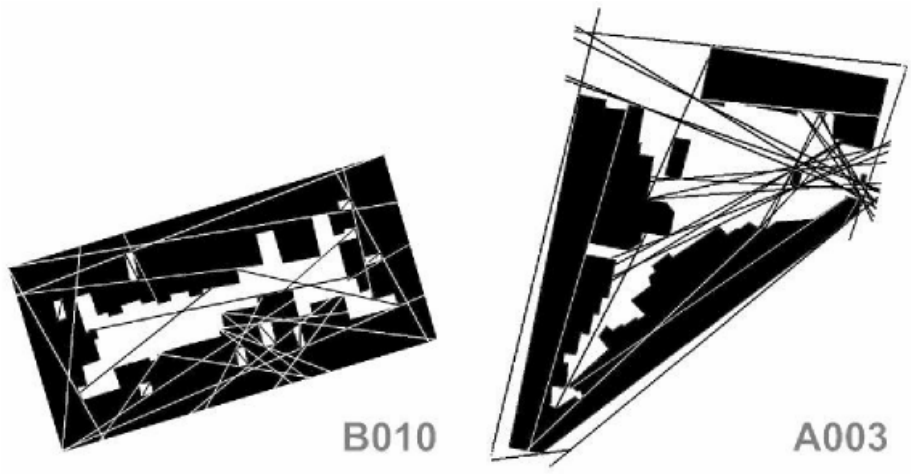


Fig.5 Axial maps of two sample plans

Properties of axial maps have been shown to relate to spatial perception and therefore to the experience of spatial identity [1]. Their ability to represent both topological and geometrical attributes of space contributes to their success in capturing multiple configurational qualities.

A method, developed by Hanna [11], for mapping axial map representations of plans into high-dimensional feature space using axial graph spectra, or ordered sets of eigenvalues, was implemented in order to classify building block plans from different areas (Figure 6).

As the comparison between high-dimensional data can be complicated, principal component analysis (PCA) was implemented in order to reduce dimensionality and highlight differentiations within the dataset. Principal component analysis is “an unsupervised approach to finding the “right” features from the data. (...) It projects d-dimensional data onto a lower dimensional subspace” [14]. The dimensions of this new feature space, or Principal Components, are strictly computational and do not represent specific dimensions of the original high-dimensional space.

The method of classification of axial graph spectra through PCA has been previously used for the description of different architectural styles through the definition of feature space archetypes as well as for the classification of plans of different building types [12].
It has been shown to be a method that enables the automated representation of plans within a uniform feature space in a way that depicts degrees of differentiation without requiring explicit description of the attributes compared [12].

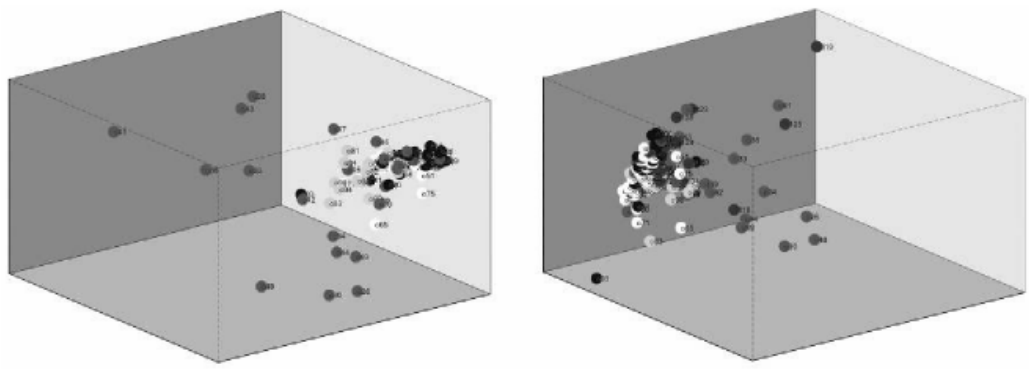
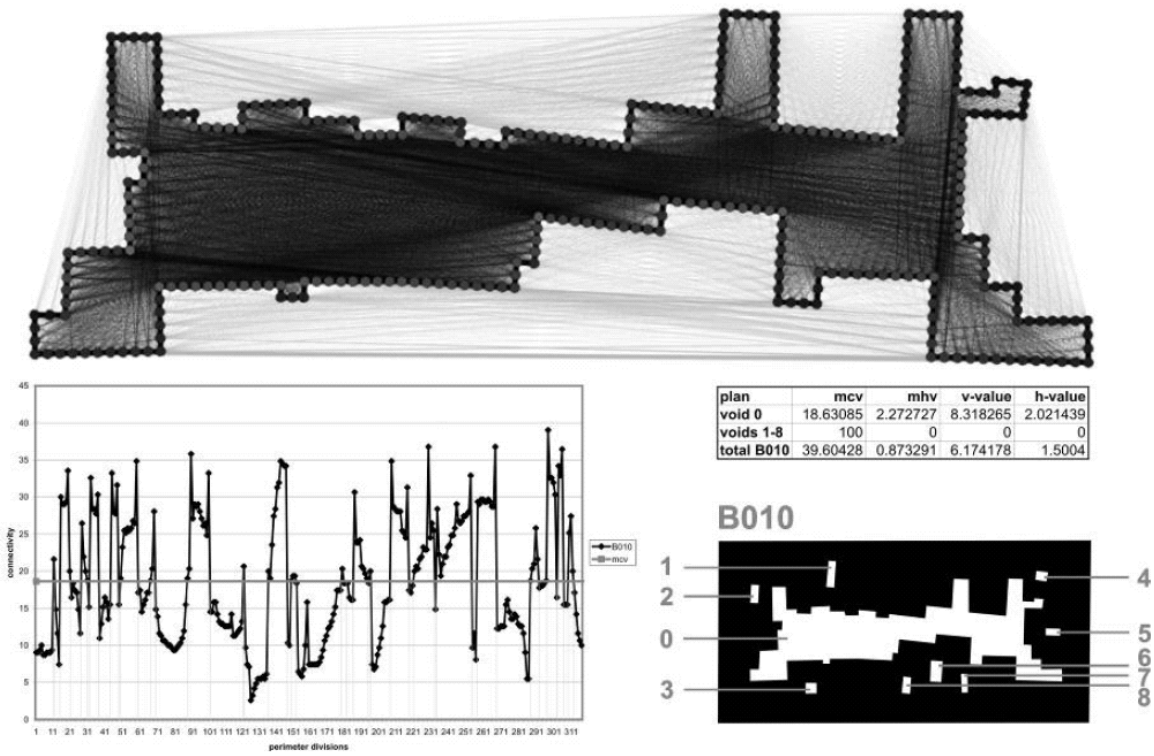


Fig. 6 Plots of the sample's axial graph spectra in three-dimensional space. Blocks from Athens (left) and from both Athens and London (right)

b. Convexity through connectivity of shape perimeter

The experience of open spaces within the building blocks is directly related to the way they are gradually revealed to visual perception. A method that measures shape convexity, introduced and developed by Psarra and Grajewski [6] offers a combination of local and global, sequential and synchronous approaches of visual experience, and is based on the description of syntactic properties of shape perimeter, by quantifying their convexity in terms of distribution of connectivity along the perimeter.



plan	mcv	mhv	v-value	h-value
void 0	18.63085	2.272727	8.318265	2.021439
voids 1-8	100	0	0	0
total B010	39.60428	0.873291	6.174178	1.5004

Fig.7 Connectivity measurement

Approaching shape from its perimeter, this method was considered to be suitable for the specific analysis, since the open spaces within the building blocks are initially and often uniquely experienced through their perimeter, either from the edges adjacent to streets or through the windows of the facades of the surrounding buildings.

In order to calculate connectivity, the perimeter of the shape is subdivided into segments of equal length. From the subdivisions a complete graph is derived, where all points are connected to each other (Figure 7, top). The number of connections that lie completely within the perimeter is calculated for each point and plotted on a graph (Figure 7, bottom left). The average of these values gives the mean connectivity value (mcv) for the shape whereas their standard deviation from mcv is defined as v-value. The average distance between subsequent points of mean connectivity represents the mean horizontal value (mhv) and the standard deviation of all these distances gives the h-value for the shape.

These values correspond to global and local characteristics of shape, in terms of stability and change, rhythm and repetition [6], [7].

Scales of analysis

In order to arrive to conclusions about relations between plans, neighbourhoods and possibly the two cities, but also about the suitability of the methods, the data was examined both at the level of individual building blocks and at the level of the local area, through the analysis of patterns occurring within each single measurement, by combinations of measurements in pairs and by the simultaneous consideration of the whole set of measurements.

Limitations of methodology

The main issue that this analysis attempts to approach is whether and to what degree quantifiable attributes of spatial representations, and specifically plans, can capture elements related to the experience of spatial identity. There are important limitations inherent in the question itself, as major issues concerning the formation and perception of spatial identity are not even spatial, let alone be captured in a plan. However, it has been proved that some aspects of spatial experience are indeed related to spatial layout, being influenced by it and reflected in it [1],[3],[4],[5],[6],[7]. The focus might thus be shifted to the validity of objective measurement of these aspects, since they are usually related to non-discursive spatial attributes.

A second level of limitations is imposed by the specificity and particularities of the selected dataset under analysis and by the nature of the measurement methods per se. Furthermore, the set of specific selected methods is not necessarily the most suitable for the description of the data- set. Nevertheless, the fact that it covers different categories of spatial attributes, and the observation of occasional information overlap between certain measurements, enforces its adequacy.

Results and possible interpretations

Single quantities

Individual plan scale

At the scale of individual blocks, looking at extreme values in each neighbourhood for each quantity, certain correspondences between measurements were revealed.

From the observation of the most intensively differentiated plans it was made clear that there is some conformity between the measurements deriving from the different methods. Their relative magnitudes are not related in a constant way, but extreme values repetitively converge towards the same plans (Figure 8).

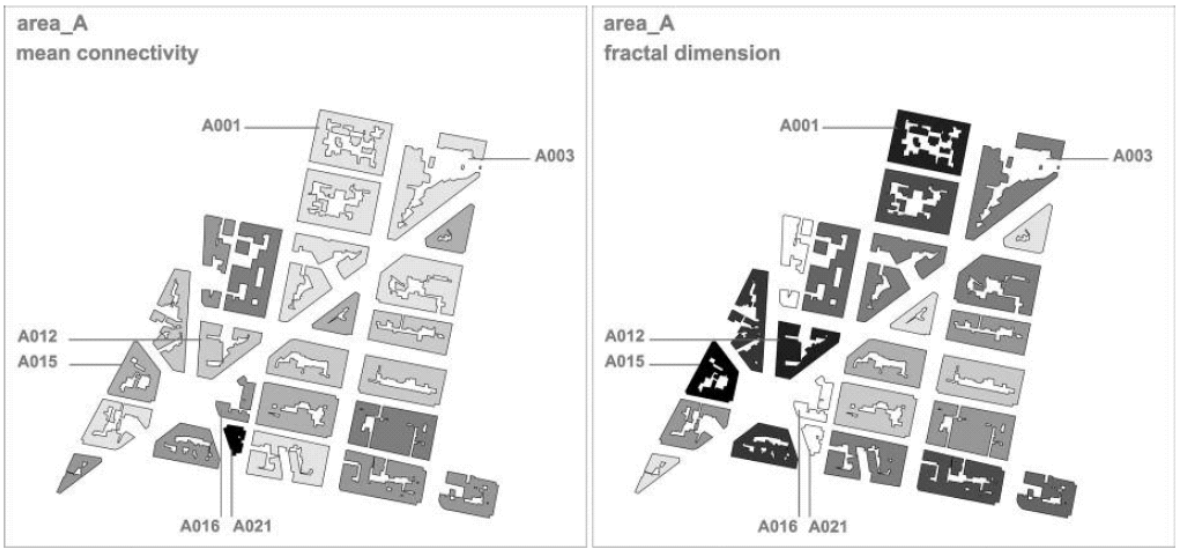
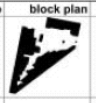


Fig. 8 Comparison between mean connectivity and fractal dimension values in area A. Extreme values (numbered blocks) often coincide in variable relations.

The PCA classification of the axial graph spectra was shown to distinguish as highly differentiated plans with high values in certain scalar quantities, related to the size and geometry of space rather than topological relations (Figure 9).

point No	block No	block plan	mcv	v-value	fractal d.	total area	buildings	built No.	void per.	void No.	open%
03	A003		18.347	8.27	1.454	8736	18	5	511	1	100
26	B001		97.39	2.157	1.352	2403	13	1	141	9	2.222
71	C021		32.867	6.42	1.575	6153.5	27	5	802	7	57.143
119	L019		73.92	5.523	1.506	12029	75	1	1488	64	48.438

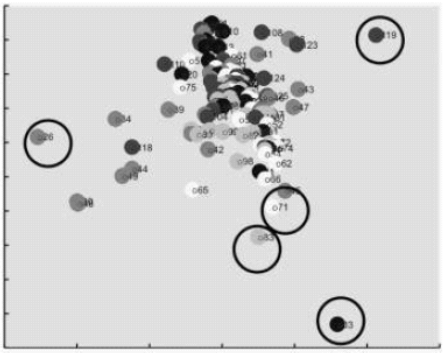


Fig. 9 Spectral analysis and scalar attributes. Outliers in the plot deriving from the PCA (circled, right) present repetitively extreme values in scalar attributes (left).

This might derive from the fact that larger plans, incorporating greater numbers of distinct elements, have the possibility of more diverse configurations than smaller ones [15], exhibiting thus a wider range of differentiation, or it might just mean that the spectra of the axial graphs are affected more by global metric transformation than local topological relations.

Neighbourhood scale

At the scale of the neighbourhood, comparisons were attempted according to the patterns of distribution of values for each quantity. In all cases the ranges of values corresponding to the various neighbourhoods overlapped. This showed that the distinct character of each area cannot be directly connected to single measurements. However, differences in the distribution and range of values do reflect some general characteristics. These were illustrated by sorting the values of each area from low to high and plotting them into graphs.

Although for single measurements differences were too fine to categorise the neighbourhoods, when considering different quantities the conversion towards persistent patterns of general ranking revealed some agreement of the ordered graphs with the experienced impression from the respective places.

For example, fractal dimension and mean connectivity exhibited very similar overall ranking in the case of Athens, ordering the different areas in terms of global complexity and fragmentation in a sequence that corresponds to the age and historical layering of each area (Figure 10).

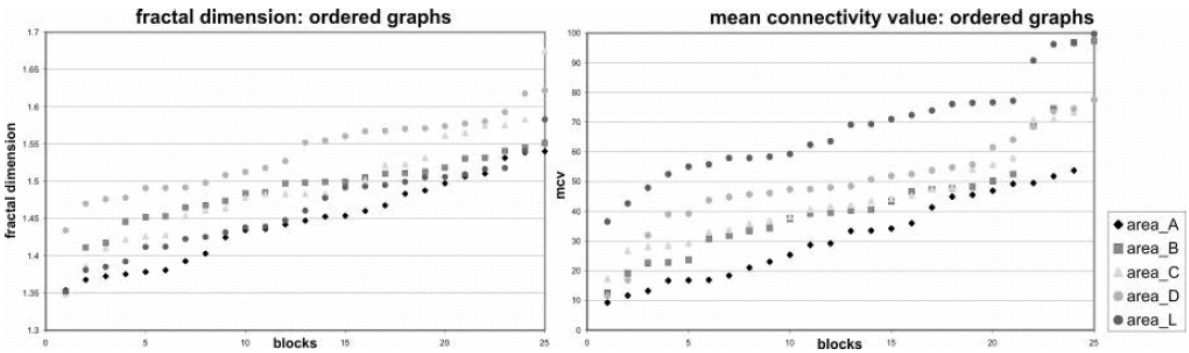


Fig. 10 Similar ranking deriving from fractal dimension and mean connectivity

Values concerning the characteristics of open spaces, such as the number, perimeter length and accessibility of open spaces in each block, reflect historical changes in the social role of open space, namely the shift from open space as a locus for social encounters, expressed through accessible, large courtyards in older areas, to open space as building infrastructure, reflected in the prevalence of fragmented, inaccessible light-wells in modern areas.

These and similar observations show that, although each single measurement is not sufficient for differentiating between the neighbourhoods or comparing blocks, the relative distribution of values seemed to have captured particularities of the areas that are usually not considered as directly related to spatial attributes, such as historical depth and certain social practices.

Pairs of quantities

Quantities corresponding to different categories of attributes (scalar, geometric, topological) were combined in pairs in order to illustrate complementary features inherent in the plans. Measures that in the previous level of analysis were shown to be related to each other were also paired up.

These pairs of quantities were plotted in scatter graphs, through which both the relation between the quantities themselves and general tendencies within different neighbourhoods were investigated. In most cases the overall impression was rather mixed, with groups of points corresponding to plans from different areas overlapping. However, when considering each area as a unity, differences in the slopes of the regression lines that best describe the points of each neighbourhood revealed differences in the overall behaviour of the distinct sets.

For example, by plotting mean connectivity against the other connectivity measurements, an interesting pattern emerged through positive correlation of values in all areas of Athens and negative for London, showing opposite trends for the two cities at a global scale (Figure 11).

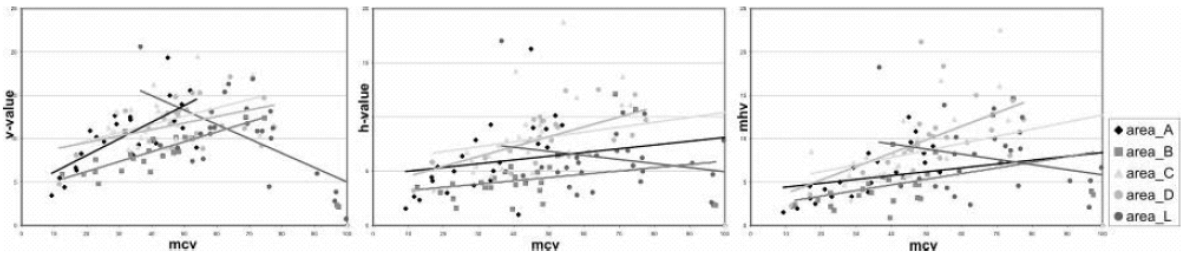


Fig. 11 Connectivity: Opposite tendencies between Athens and London

This fundamental difference might reflect the different processes that have prevailed in the formation of the two cities. Uncoordinated local actions in Athens led to differentiated, unequally distributed open spaces, whereas the equal distribution of open spaces in London is often the result of organised global processes of design and construction.

Such observations, deriving from the various measurements and their relational comparison, revealed that the combination of different quantities in pairs might again not be sufficient for the distinction between neighbourhoods or for the description of their particular character, but general trends that reflect specific relations between spatial attributes can be studied. These relations characterise each area as a heterogeneous but indiscernible whole and represent intrinsic tendencies associated with abstract expressions of spatial identity.

Set of quantities

This level of analysis, where each area is uniquely defined through the specific set of blocks constituting it, does not allow the classification of unlabelled examples. It reckons each area through a complete, finite set of given elements and attempts to reveal if and to what degree quantifiable attributes of specific blocks reflect the whole set of elements that constitute the neighbourhood.

In order to view this system of relations within a wider context, a more global structure was formed, within which the character of each element, as reflected in the values given by the measurements, and its location within the system would be uniquely related. In this system, unlabeled blocks would be identified according to their absolute location within the structure.

In this view, it was attempted to combine all measured attributes of the blocks in a high-dimensional structure, where each block would be represented as a uniquely defined point. The representation of such a structure was made possible through the implementation of principal component analysis. It should be noted that even though in the high-dimensional structure each block is uniquely represented independently from the other blocks, in the reduced feature space the location of each point depends on the composition of the set.

By plotting all measurements regarding the four areas of Athens and projecting them on the first two Principal Components, a clear distinction between areas was observed. Apart from some exceptions, there was a division between older and modern areas (Figure 12).

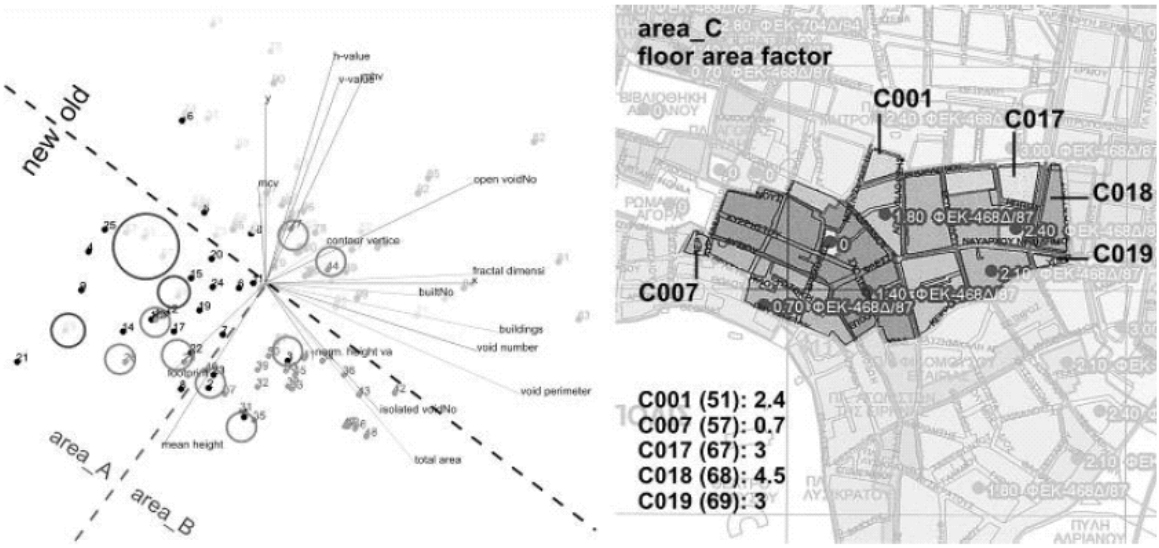


Fig. 12 PCA classification for the areas of Athens. Differentiation of old and modern neighbourhoods (left) and misclassified blocks in area C (right, numbered)

In the case of misclassified blocks from area C, it was noted that these are subject to building regulations standing for modern areas (Figure 12, right). This might signify that the PCA classified correctly blocks that were erroneously considered as belonging to a specific neighbourhood.

However, the introduction of the data regarding the area of London altered the interrelations within the system, resulting to a redistribution of the points representing the blocks (Figure 13).

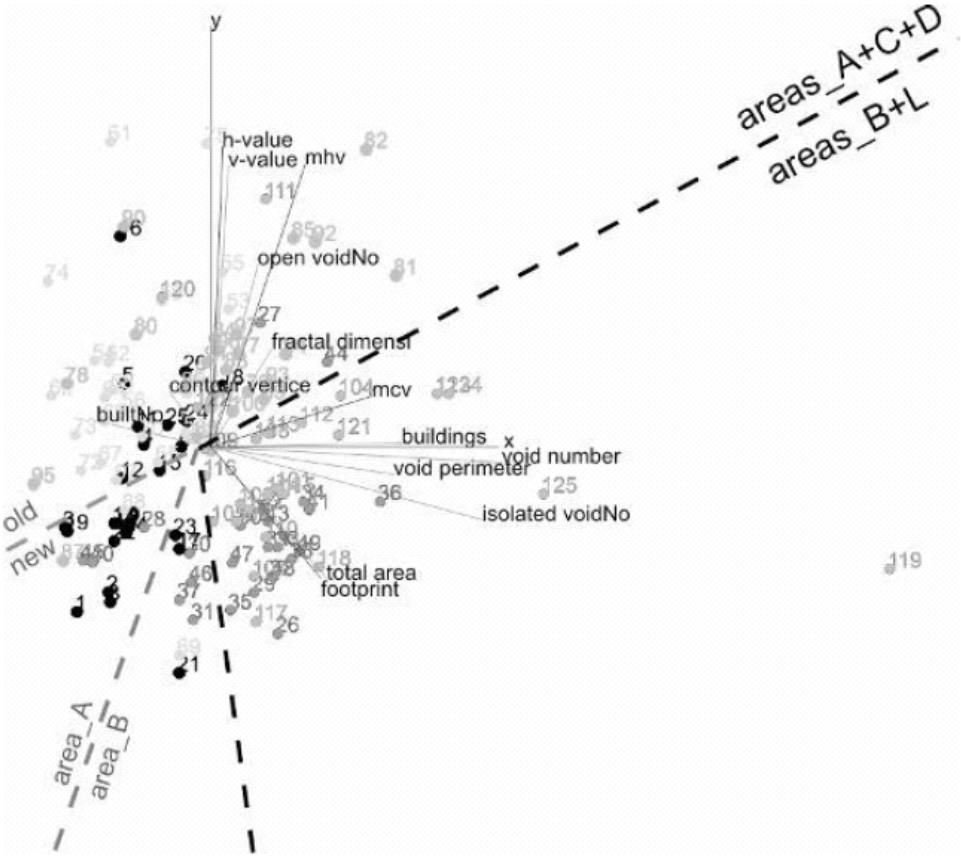


Fig. 13 PCA classification of the whole dataset

When plotting the system against the first three Principal Components, this redistribution led to the formation of two composite clusters with some overlap between them. The new distribution indicates that, on one hand, differences between areas A, C and D were weaker than the overall differentiation from London and on the other hand similarities between area B and London were more intense than similarities within the city of Athens.

The formation of two clusters might reflect the different processes that generated the areas in each. Of course these processes are specific to the unique circumstances characterising each locus, but they could be very generally distinguished into prevailingly global or mainly local. The cluster consisting of areas B and L could thus be claimed to be characterised by global forces of formation whereas the cluster including the rest of the areas could be related to local actions.

It is true that neighbourhood B is the most thoroughly designed area of the Athenian sample, having been a privileged bourgeois location since the nineteenth century. This top-down process of formation might abstractly relate area B to London, where global decisions seem to have prevailed over local actions of spatial administration and control.

On the contrary, the other three areas were grown out of local actions and initiatives, through the conflict and equilibration of personal interests and small scale revendications. Even in the case of area A, which was massively rebuilt during the construction boom of the fifties and sixties, the forces of schematisation were largely localised, with the main driving force of construction being private investment [16],[17].

Because of the alteration of interrelations between the blocks according to the composition of the dataset and considering the unequal proportion of data concerning the two cities, the area of London was compared with each area of Athens separately (Figure 14).

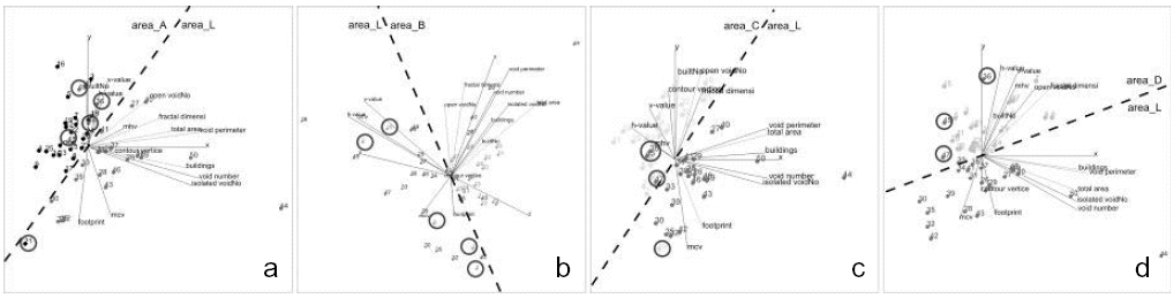


Fig. 14 PCA of the area in London and each of the areas in Athens

In accordance with the overall plot, area B presented the least differentiation. However, despite the overlap, a general tendency of the blocks belonging to the same area to cluster was observed (Figure 14b). The distinction between clusters was clearer in the plots of the rest of the Athenian neighbourhoods against the London sample and consistency was noticed in the misclassified blocks from London (Figure 14a, c, d).

Based on these observations, it could be claimed that, given wide enough amounts and variance of information on quantifiable spatial attributes, it is possible to distinguish between neighbourhoods based on their degrees of identification and differentiation. The relative distances between points representing blocks reflect the degree of variability, with similar blocks naturally falling closer together and highly differentiated cases being plotted far apart.

From the quantitative description of disconnected block plans, patterns of attraction and repulsion emerged that reflect both the unity and continuity of local identity, as it is formed through locally contiguous heterogeneous particularities, and the translocal relations between spatially discontinuous elements.

Discussion

Through the combination of different methods of shape and spatial analysis it was attempted to examine patterns of distribution and interrelation between various quantifiable attributes inherent in spatial representations, in order to illustrate complex relations of identification and differentiation between urban areas.

These methods were selected based on their different approaches to processes of spatial experience and were shown to complement each other in the description of spatial configurations and their interrelations, since they reflect related but distinct aspects of layouts, regarding scalar, geometrical and topological attributes. However, constant high correlation between specific quantities might reflect some redundancy in the measurements.

The examination of each quantity individually, led to the conclusion that even though a single measurement might be insufficient for the description of space and spatial interrelations, when applied to a labelled population, the range and distribution of values can reveal general relations between sets of building blocks. It also revealed relations and correspondences between the quantities themselves, indicating the convergence of results deriving from different methods.

These interrelations were examined in more detail through the scatter graphs of pairs of quantities. The overall degree of correlation between the quantities represented by the two axes indicated the general character of their association. The examination of patterns produced by the clustering or dispersal of points corresponding to block plans belonging to the same neighbourhood and of differences in the slopes of the regression lines best describing these points, revealed comparable general tendencies within each neighbourhood, illustrating degrees of differentiation or accordance.

The overall structure of these convergences and divergences between different areas, based on degrees of identification and differentiation between individual blocks along all measured quantities, was approached through the three-dimensional representation of the high-dimensional plotting of all measurements.

All three different scales of analysis have shown that the measurement of quantifiable spatial attributes might lead to the detection of degrees of differentiation between neighbourhoods that correspond to local particularities not directly related to the specific quantity. As inferred from the analysis of the results, such particularities regard the historical layering of construction periods coexisting in each area, elements connected to social practices such as

the role of private open space as a locus for social interaction, the particular social, historical and political circumstances that formulated processes of construction, leading to the prevalence of global or local forces or the local and translocal propagation of spatial models related to social identity.

It could thus be claimed that configurational features manifest in plan representations, that by their own only partially reflect elements relevant to spatial identity, when used for the quantification and comparison between a population of plans, can be used as indices of relations that expand over the confined significance of the feature per se. It is not the measured attributes that reveal elements of spatial identity, but the way in which this identity has shaped and is reflected in the specific spatial configurations exhibiting the features under measurement.

However, the comparison between plans according to quantifiable spatial attributes can only express relative degrees of differentiation in an abstract, quantitative manner and further interpretation of these relations requires specific domain knowledge.

According to this observation, the analysis of a population of plans would result to an abstract illustration of the structure of attractive and repulsive forces between individual plans, in terms of degrees of identification and differentiation rather than to explicit information about the nature or causes of these relations.

At the first two levels of analysis, where quantities were examined individually or in pairs, the plans were labelled. In this case, general tendencies within the neighbourhoods were viewed as resultants of the internal forces within predefined sets of plans and relations between these resultants illustrated the relations amongst the corresponding neighbourhoods. At this level, local forces prevailed over translocal relations as each area was defined as a discrete unity and as such compared to other unities.

At the third level of analysis, where all quantities were considered simultaneously, the blocks were unlabelled and the structure of the field of forces emerged from the innate relations of every plan with every other. The fact that plans corresponding to the same areas naturally clustered together indicated that, as a general trend, local forces of identification indeed prevailed over transpatial attractions. However, the effect of transpatial relations was also manifest through the tendency of individual plans to cluster with blocks from different physical locations. The presence of transpatial relations was intensified with the introduction of the plans from London in the system that shifted the whole relational structure in an unpredictable way, changing the axes of projection and fortifying simultaneously the

expression of local attractions within three areas of Athens and of transpatial attractions between the fourth area of Athens and London.

This reveals the relative nature of the system and the possibility of its application as an index of perceptual degrees of differentiation between a specific set of plans rather than an objective general measure.

Conclusion

The combination between different methods of shape and spatial analysis enabled the quantification of a range of spatial attributes regarding scalar, geometrical and topological features inherent in plans of urban blocks. The analysis of the resulting values at different levels of observation led to the gradual structuration of a system of forces reflecting spatial and transpatial relations according to degrees of identification and differentiation between neighbourhoods.

This system, representing the distribution of non-discursive spatial characteristics related to the perception of space, could be viewed as an abstract map of intensities through which spatial identity is experienced. Therefore, although spatial identity cannot be explicitly described through quantifiable spatial attributes as represented in plans, its continuity, indivisibility and heterogeneity can be abstractly perceived through the field of forces constantly rearranging the elements from which it emerges.

The investigation of the correspondence between closely related groups of plans and the relevant values and distributions in specific measures could possibly lead to the extraction of general rules that could inform design processes in the direction of reproducing elements of spatial identity independently from the repetition of specific morphological, configurational and technical characteristics. Spatial identity could thus be preserved through space and time detached from the replication of established configurations and architectural styles.

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