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Is Urban Diversity Synonymous with Urban Sustainability? What do people "suggest" for Clerkenwell in London?

I. Perdikogianni and A. Penn
The Bartlett School of Graduate Studies, UCL, London, U.K.

Abstract: This paper draws on current research being undertaken under the VivaCity 2020 Consortium (EPSRC Sustainable Urban Environment (SUE) programme) and describes a "well-working" diverse area in London; Clerkenwell. It further builds up empirical evidence of the relationship between land use diversity and urban sustainability. It is often argued that a diverse urban environment can be seen as a positive component for sustainable urban communities. However, it is possible to find diverse areas, which fail to "work". By identifying the absence of a robust definition of diversity, the paper describes Clerkenwell's large-scale spatial and functional patterning in detail and identifies that it comprises a system of different centres of activity developed around locally strategic streets. Its occupational patterns emerged by observation-based land use, pedestrian and traffic flow surveys correlated with configurational measures that describe its structure. This paper suggests that cities should be understood as a dynamic product of a long historical process, based on the cause-effect relation between "physical city" (means) – "functional city" (ends). Then, urban sustainability although it refers to the ends, is always bound to means-ends binary relation

1. Introduction

1.1. Problem Definition

Urban diversity is seen as a positive component for sustainable urban communities (ODPM, 2000, 2004). The argument is that diverse urban neighborhoods support local services so that everyone lives within walking distance of schools, shops and work, reducing transport costs (Owens, 1992), and furthermore that within them the sense of community is reinforced since stronger local social and economic networks are developed.

However there are different definitions of diversity. The term has been used to describe areas of heterogeneous social composition, ethnic and cultural mix (Brindley 2003), as well as mixes of land use (Breheny, 1995; Campbell, 1999; Jacobs, 1961) and spatial and architectural form. However, none of these proves to be completely satisfactory since none of them describes the complexity of different factors that contribute to what is called a "successful" and sustainable urban environment. Hence, it is possible to find urban areas of great heterogeneity that seem to fail to "work" as in many modern "mixed-use" developments. Equally, conflicts over use and lived experience arise when non-compatible uses are mixed in particularly high density confined spaces, and where it seems that some degree of separation of functions could improve the situation. (Thomas and Bromley, 2000; Bromley *et al*, 2003). "Well working" diversity seems to be one of those phenomena that "we know when we see it" but for which there is not currently a robust definition.

This paper aims at enriching our understanding of diverse urban areas by exploring in depth the spatial and functional patterns of a “well-working” diverse urban area: Clerkenwell in London. The main conjecture that underpins this study is that an urban environment can be described as a means-ends system in which the means are its physical environment while the ends are the functional processes and social interactions which take place within it This binary relation suggests that urban sustainability is about the ends (functional city) (Hillier, 1996).

Clerkenwell is the first case study of the VivaCity 2020 Consortium (EPSRC Sustainable Urban Environment (SUE) programme), an ongoing research project within the Space Syntax Laboratory at UCL in collaboration on this workpackage with Graeme Evans, Jo Foord and Rosita Aeisha of London Metropolitan University. This project aims at generating a better understanding of exactly what diversity is and how this depends on the spatial morphology of an urban area by identifying and exploring “well-working” diverse urban areas, as well as those that seem to have failed.

Clerkenwell was selected as an area which appears prima facie to be an example of successful diversity and where its diverse character is considered valuable enough to be protected by the local planning system (London Borough Islington 2002). The area maintains many Victorian buildings and its functional identity mainly draws on a great variety of uses including specialist manufacturing, workshops, wholesaling, retailing activities, offices, residences and a significant number of entertainment activities. The selection of Clerkenwell as a case study is also justified by its location on the northern fringe of the City of London (London’s central financial district) (Figure1). This paper identifies Clerkenwell’s large scale heterogeneous spatial and functional pattern, and it explores whether there are any morphological or historical reasons, or any other factors such as the presence of particular attractors that could account for its heterogeneity. By exploring the degree of diversity, the paper identifies the micro-scale patterning focusing on different centres of activity developed within the area and it attempts to investigate how this feeds into its large-scale diverse pattern.

The paper starts by exploring concepts such as urban diversity in terms of urban sustainability. It reviews urban theories that have been developed to investigate urban complexity and focuses on the spatio-analytical theory of space syntax. It then explains the research methodology and reviews the mutli-variate analysis of large scale and micro-scale patterning of Clerkenwell. Finally, drawing on the initial findings of this analysis it suggests that Clerkenwell comprises different sub-areas which explains why this area considering its large scale, emerges as a heterogeneous entity. It suggests that the historical evolution of its structure may account for the development of different sub-areas and that this phenomenon acted to inhibit Clerkenwell’s economic development despite its location next to the City of London. However its failure to redevelop led the area to its current planning status as conservation area in which diversity is one of the primary characteristics of value.

1.2 Sustainable Diverse Urban Environments-. How can we achieve that?

Despite the apparent desirability (and promotion) of diverse urban environments, achieving this through urban design and planning policy has proven to be problematic. The intensification and clustering aspects of mixed-use can be perceived as being environmentally problematic and a high risk (but low value) development opportunity (Evans 2005). Conflicts over use and lived experience arise when ‘24-hour’/night-time activity or other non-compatible activities in mixed or residential areas create disturbance within developments The issue has otherwise highlighted by those who suggest that there are key variables that one can take into account while mixing different uses within a given urban area. Thus, it is suggested that attention needs to be paid to the location of uses and activities in relation to one another; the nature of users and premises; the pattern of comings and goings; the mix and balance of primary and other uses; the compatibility and synergy of uses; the intensity, density, permeability and grain of development; and to detail such as street layout and the ease of movement and density of footfall along routes (Rowley, 1996).

Figure 1 City Fringe: areas bordering the northern and eastern boundaries of the City of London

There are urban theories that prioritise the street and its properties in the creation of vibrant and diverse urban environments. It is proposed that the degree of choice offered to city dwellers (in relation to urban amenities and resources) emerges primarily from the physical environment. Hence, the physical arrangement of a city or a neighbourhood, limits or opens up new possibilities in the way people choose to live and work (Martin 1972).T Or else street patterns combined with the activities that take place on the street frontage affect the possibility and form of encounters between people (Jacobs 1961). This interpretation suggests that the growth and dynamism, or the stagnation and decline, of city life are dependent upon the street patterns (or else spatial patterns) and its potential to facilitate activity and interaction. This approach suggests that in an urban system there is an interdependent relationship between urban form and patterns of living.

In particular a systematic relationship has been claimed between spatial layout and patterns of people's use of public space (Hillier and Hanson 1984). In this framework, it has been suggested that the urban grid itself creates patterns of city life through "configurational inequalities" which in turn produce "attractional inequalities". (Hillier, 1996: 168) This theory describes cities as spatial systems that create busy/dense mixed-use and quieter/dispersed mono-use areas identified by their different configurational and functional properties. Using this approach, urban sustainability becomes a question of density and whether cities should be nucleated or dispersed, concentric or polycentric.

However, cities function as social objects as well through the spaces that people occupy. The spheres of urban spatial configuration are connected through levels of movement within the urban network.. It is proposed that movement patterns shape land use pattern and at the same time land use patterns generate movement (Figure.2) However, Space Syntax research has found that a substantial proportion of people movement patterns in cities is generated by the structure of the urban grid itself. (Hillier, Penn et all 1993).

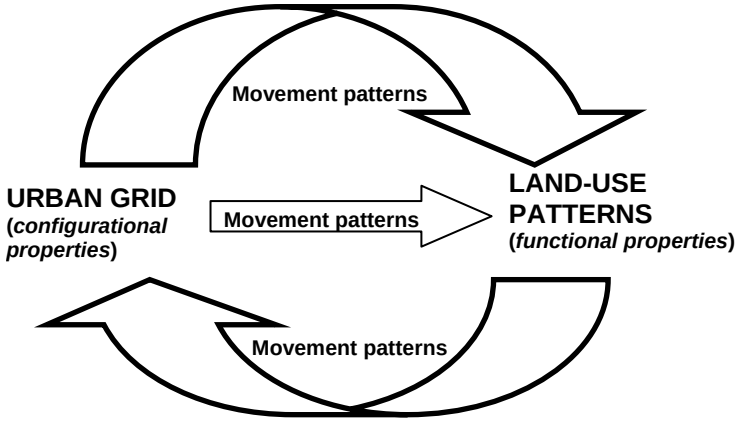


Figure.2 The urban grid is conceived as a system of "configurational inequalities" which generates a system of "attractional inequalities" described as the theory of "movement economy (Hillier 1996)

These movement patterns reveal how people experience a given urban area. For space syntax research users' experience is described by the concept of "intelligibility" This is defined as the degree to which from every (local) position we (pedestrians) can have a visual understanding of their (global) position in the environment overall (Hillier, 1996: 129). The dialectic relation between local to global scale characterises an urban area as an intelligible one. This spatial property suggests that cities to be understood and analysed at different scales: the macro scale of the city as a whole and the micro scale of different localities.

In this theoretical framework, this research explores further the mechanisms that compose the local scale of different localities into one intelligible entity. It also proposes a re-examination of the relationships between physical and functional space. Urban complexity requires a new exploration of the interrelationships between urban land-use patterns; spatial movement; distribution of socio-economic activities; processes of development, planning and resource allocation; and the actual experience of people.

2. Case Study

2.1 Research Methodology and Data

The study takes space as a common framework and using a GIS system to create an integrated spatial and functional database for the study area, brings together observation-based surveys of land-use, space-use and pedestrian flow. Land use data was collected in December–January 2004 through observation for 3616 premises within the case study. Uses of ground floor, first floor and the main use above first floor were recorded and classified as Residential premises, Commercial and public offices, Retail, Services, Catering, Community facilities, Education, Emergency Services and Law, Hotels, Industry and Manufacture, Leisure and Entertainment, Medical facilities, Storage, Transport and Communications, Car parks, Open Public Space, Under Construction, Undeveloped land and Vacant premises according to NLUD Classification Version 3.2TT. Pedestrian flow data were gathered for 132 different street segments between street intersections n the centre of the study area. (Figure 3) The study used the "gate method" (Space Syntax Lab, 1997). The observations were made during 9 time periods between 8.00a.m and 8.00p.m during one working day and one Saturday by a group of 15 observers.

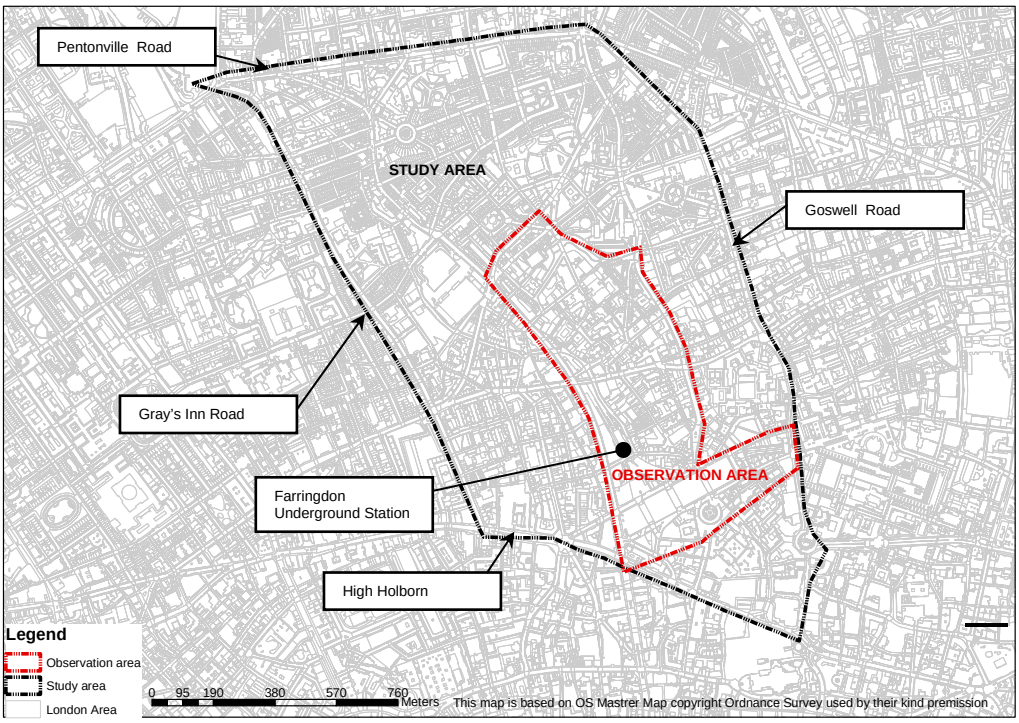


Figure 3. The boundaries of study and observation area. (the area within which observation-based pedestrian survey has been conducted)

The spatio-analytical methods employed are based on space syntax techniques. Hence, Clerkenwell's spatial system is analyzed configurationally using two main space syntax methods, axial analysis and segment based network analysis. The first represents urban grid (street system) as a matrix of the longest and fewest lines of direct access that pass through all the spaces and make all the connections. This model referred as "axial map" is analysed in relation to its "topological" properties by translating the line matrix into a graph and measuring the topological properties of the graph. The measure of integration captures the potential effect of spatial configuration on movement patterns. Global integration (or radius n integration) measures the mean depth (distance) of all axial lines in a plan from the line in question to all other lines. This is normalized for the number of lines that are present in the plan. Local integration (or integration radius 3) accounts for the relationship between each line and all other lines restricted to two changes of direction away from it (Hiller and Hanson, 1984). The second analysis is based on the axial (pedestrian) map but disaggregates each (axial) line into a series of line segments between street junctions. The model represents the urban grid as system of least length, least angle and fewest turn paths. The distance-depth in the map is measured according to angle change (segment angular model). Mean Angular Depth (MAngD) measures how much change of direction is involved in order to get from each segment to everywhere else in the system and what is taken into account is the angle that each segment meets its adjacent ones. The model otherwise reflects cognitive conjectures about how people interpret spatial networks for navigation (Hillier and Iida, 2005).

The whole analysis is structured into a series of stages. Clerkenwell's functional identity is described in detail using descriptive statistics. Its spatial system is analysed configurationally embedded into its surroundings to a radius of 3km around the study area as well as an independent system. The measures of "intelligibility" and "synergy" are employed to describe the urban system considering them as key properties of a given urban environment that enable pedestrians to navigate. Both measures are expressed as the degree of correlation between global (topological) properties of the graph (e.g.*global integration*) and its local properties (e.g. *connectivity*, *local integration*) also represented by a scattergram (Hillier, 1996:124). The experiential argument is also explored through the correlative analysis between configurational measures that describe the spatial structure (local integration and MAngD) and pedestrian

movement flow. This analysis shows that Clerkenwell is a heterogeneous urban system. Actually, it reveals that comprises of 6 sub-areas that are embedded within larger independent systems developed around locally strategic streets. By tracing the historical process of Clerkenwell's structural evolution our understanding of its current spatial and functional patterns is enriched.

2.2 The "Mixed-Use" Clerkenwell: Spatial, Land Use and Temporal Patterning

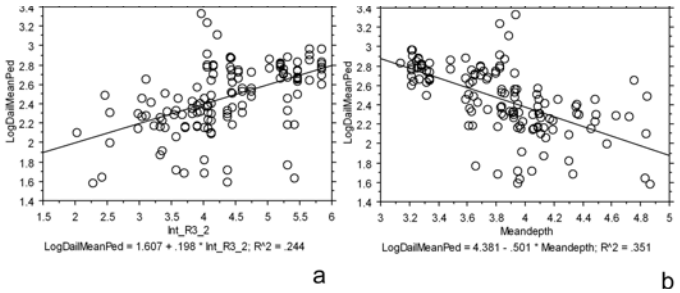
The land use survey shows a spatial separation of mono-functional, mainly residential in the north, and more commercial or mixed-use environments in the south for the ground floor use. The sub-areas in the north of the study area have a limited range of other uses other than residential with occasional newsagents' shops or pubs often located on street corners. These uses are identified either as retail, services or leisure and entertainment in our survey. The mixed-use areas located in the southern part are dominated by office and retail uses although they have a significant number of other uses such as community facilities, services, leisure and entertainment and residential premises.

The configurational analysis shows that the study area is an identifiable but quite unintelligible area if analysed as embedded system within its surroundings or as an independent system. In both cases, the correlation coefficients between *connectivity* and *global Integration* (r^2 = .482, or r^2 = .478 respectively), show the area to be relatively unintelligible. The movement pattern suggests an area which comprises a combination of highly used and underused spaces with the strong positive attractor of Farringdon tube station. The four busiest locations (daily mean per hour rate of over 1500 moving adults) are adjacent to the station. These numbers gradually drop as we move northwards. The frequency plot of pedestrian movement flow rates shows a positively skewed distribution. If we plot it to the same scale with previously recorded pedestrian movement data on four other London areas (Barnsbury, Carthorpe St, South Kensington Museums' area, Brompton Rd), which earlier studies (Penn et al, 1998) have been established at the segment level throughout the working day, Clerkenwell data is in a much narrower band and so has much less variation. The daily mean per hour flow of moving adults is 386 compared to 224 for London overall. This complex pattern is also affected by the variation of movement rates during working day. The plot of frequency distribution of pedestrian movement for all the locations for different times of day shows that variance in rates is greater during the lunchtime or the evening rush-hour, than during morning or afternoon periods. The standard deviation (SD) for each distribution also suggests this dispersion in the sample. (SD (lunchtime): 346, SD (evening): 384, SD (morning): 293, SD (afternoon): 273). It also emerges that even the mean rate of pedestrian movement for each location varies considerably throughout the day.

We now turn to the predictability of observed pedestrian movement from the measures of the local street grid configuration. A regression analysis between local integration (IntR_3), which previous studies have pinpointed it as a good predictor of pedestrian movement (Penn et all, 1998), and Daily Mean flow of moving adults per hour gives r^2 =.244. Its scattergram forms an untidy shape around its regression line. Based on the segment angular model the regression analysis between mean angular depth (MAngDn) and Daily Mean Adults/h flow gives a slightly greater correlation (r^2 =.351). However, this is still a weak correlation as confirmed by the dispersed scattergram. Although it is untidy it appears to contain sets of points suggesting different regression lines, indicating the existence of different sub-areas. (Figure 4).

2.3. Identifying Micro-Scale Patterning: Predictability and Functional Identity

Drawing on the shape of scattergram in Fig 4 (b), we have identified six sub-areas within the study area which comprise connected lines represented as different sets of points with individual regression lines. Thus, with a method that was developed in a previous empirical study on City of London, the analysis breaks up the scattergram into its component scattergrams, representing sub-areas but by holding the axes of Fig 4(b) steady so that different areas can be seen in the same frame. (Hiilier, Penn et al 1993). (Figures 5,6)



a b

Figure 4. Scattergrams showing correlation between IntR3 (a) MAngDn (b) and pedestrian movement flow for a working day)

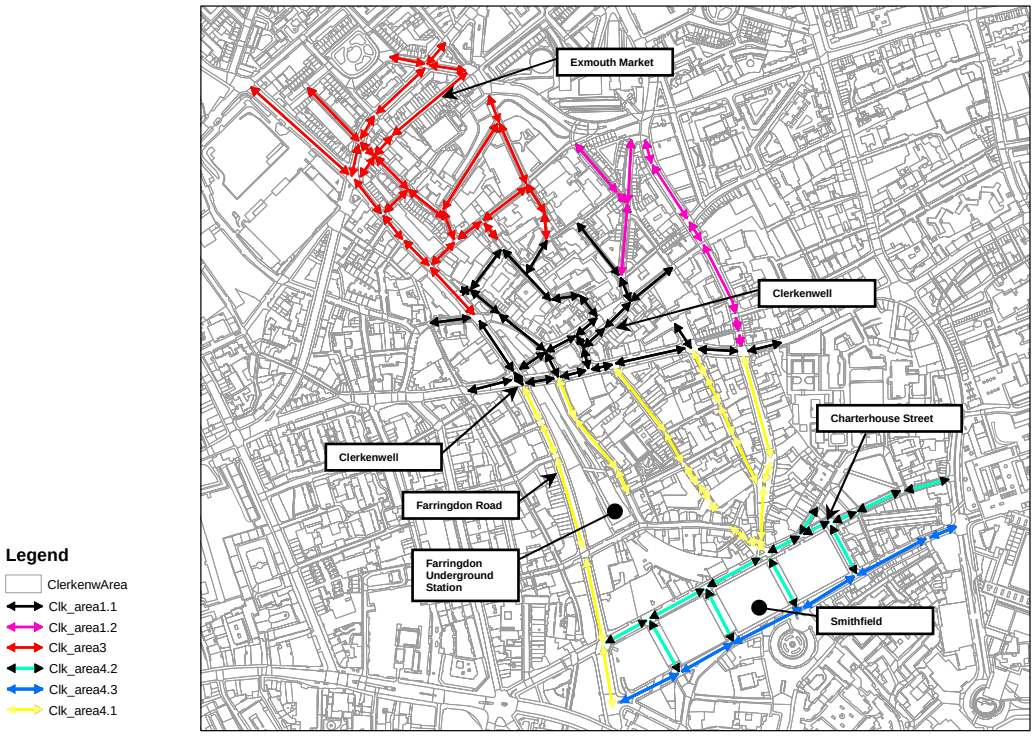


Figure 5. The six-sub-areas identified within the observation area

Figure 6(b) represents (SUB-AREA1.1) the homogeneous large set of points (30) formed around Clerkenwell Green including Clerkenwell Close. The correlation between MAngDn and pedestrian flow is strong(r^2 =.715) The axial analysis of the system also gives a high correlation coefficient (r^2 =.721) between Integration radius3 and pedestrian flow for this connected set of points. The strength of both correlations remains almost unchanged with little variation throughout the observed day (TABLE 1). Then, the study takes the eastern route from Clerkenwell Green to Clerkenwell Close through St John Street (SUB-AREA 1.2) and scatters it separately in Fig6(c). This smaller system of connected points (10) has also a very strong correlation between MAngDn and pedestrian flow. This area has a wider range of movement rates than sub-area1.1 and a significantly narrower band of MAngDn. This system's purely axial analysis gives a significantly weaker correlation between IntR_3 and pedestrian flow. Both correlations show little variation throughout the day.

SUB-AREA 3 (Fig 6d) is focussed around a main attractor of pedestrian movement, Exmouth Market. This large system of 29 gates (points in scattergram) forms quite a tight shape around its regression line. Exmouth Market, the main retail and catering street in this area lies just above the regression line, one

step away from the other main street, Farringdon Road. The coefficient r^2 =.768 between MAngDn and pedestrian flow is slightly lower than that for axial analysis (r^2 =.82) between IntR_3 and pedestrian flow.

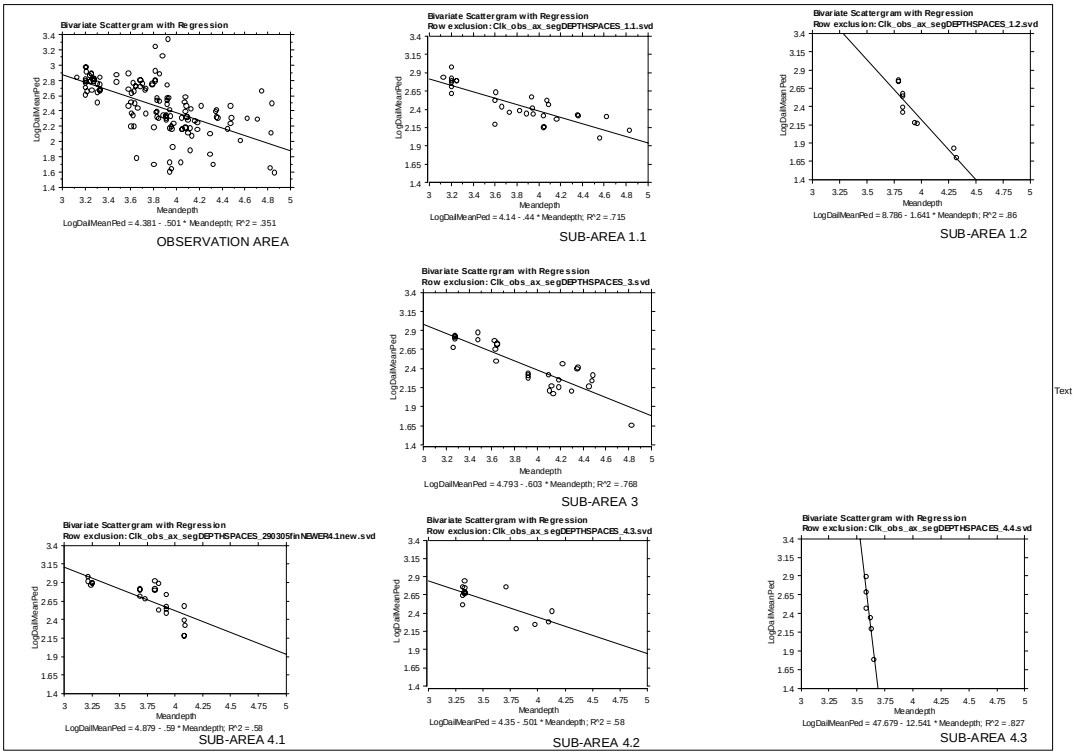


Figure 6. Scattergrams plotting mean angular depth against logged moving adults for the six-sub-areas in Clerkenwell)

If we move southwards, the effect of Farringdon underground station on movement patterns is dominating. (Figure 7) By taking into account this effect, we plot the sets of points which represents the area south of Clerkenwell Close and north of Smithfield Market. The station lies at the edge of this system. If we include all the observation gates, the correlation is distorted mainly by the locations next to the station and a system of three other streets that form part of the route from the station and northwards. If we exclude all these locations whose movement flow is clearly affected by this main attraction, (SUB-AREA 4.1) then this set of points (Fig6e) forms a tight shape around regression line (r^2 =.58). This represents all the streets which are laid out on the north-south axis of the grid. Farringdon Road appears as the cluster on the top left area of the scattergram having little significant impact on the coherence of this area.

The southern complex of the study area comprises two other distinctive SUB-AREAS, 4.2 and 4.3. SUB-AREA 4.2 is formed by Charterhouse Street, the north side of Smithfield Market along with the streets inside the market. (Fig6f) and it gives a good correlation coefficient r^2 =.588 which increases to r^2 =.672 for radius 40 angular analysis. The axial analysis of this system also suggests a distinctive sub-area. Surprisingly, this system is differentiated from the south edge of Smithfield Market, West Smithfield Street, which constitutes another sub-area as a set of points with the widest range of movement of all the selected sub-areas and a very narrow range of MAngDn values, forming a different regression line (Fig6g). Considering all 3 sub-areas identified within this southern system, in SUB-AREA 4.2 that is the area around Smithfield Market, IntR_3 correlates strongly with pedestrian flows. This can be explained by the fact that this sub-area, although it is close to the station is clearly separated from it and thus, the underground station's effect on movement patterns within this sub-area is minimised. In all other sub-areas the disaggregated least angle network model predicts the pedestrian movement flows best. The results of regression analysis between network measures and pedestrian flow are shown in TABLE 1.

Although the study area appears to be an identifiable entity as a whole, the presence of many sub-areas within its system, has been also implied by the configurational analysis. The later suggested that within the area many streets-lines are highlighted as local integrators. For example when the area was analysed as independent system, it picked up Clerkenwell Road (IntR3: 5.806). West Smithfield (IntrR3: 5.380) and Chartehouse Street (IntR3: 5.309).Farringdon Road (IntR3: 5.187) and Rosebery Avenue (IntR3: 4.955). Space syntax research has found that if a street has a high value for local integration then it appears to attract retail and leisure uses, and as such appears to function as a local centre within areas which are dominated either by residential or office buildings (Hillier 1996). However, in areas where other attractors exist which are not located on integrated spaces (for example underground stations in back streets), the functional centre may be displaced from the local; integration core.

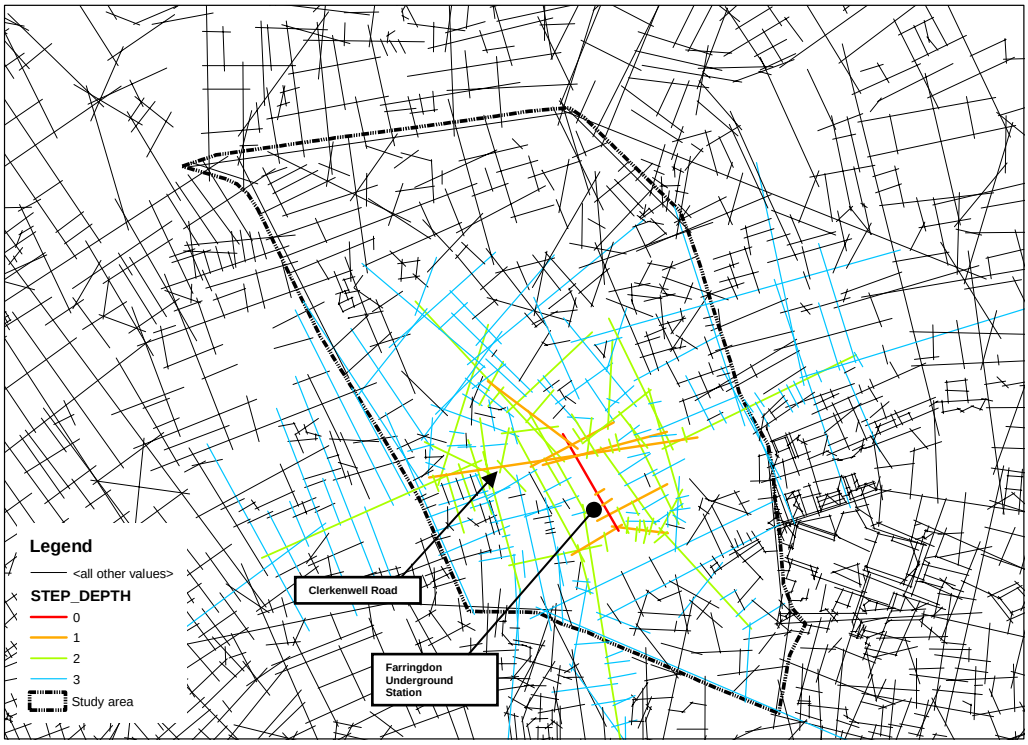


Figure 7: The axial map highlights the radius of influence of Farringdon Underground Station for the study area, showing how many changes of direction pedestrians take in order to get from the station to everywhere else (step depth).

3. Preliminary Findings or the Paradox

In the light of these data, the notion of 'well working diversity' seems to bear a dynamic relation between spatial and occupational patterns. The in-depth analysis of correlations between spatial and functional patterns, described Clerkenwell as a relatively unintelligible, heterogeneous area. We suggest that the structure itself splits the area into 6 identified sub-areas. each of which appears to have grown around specific local centres at the street segment level which attract the majority of retail, catering and leisure uses within the whole area. However, this structure is a dynamic product of the historical process during which this urban environment evolved. Clerkenwell's current spatial structure stems from its origins as an area of low lying land traversed by the river Fleet outside the walls of the City of London, used for the major cattle market for the City, and broken up by a series of larger monastic properties at the beginning and during 18th century by mansions owned by town merchants (Pink 2001). One recent study highlights the morphological changes of its urban grid mainly due to road improvement programmes during 19th century. These introduced new roads like Farringdon Rd, Charterhouse Str, Clerkenwell Rd and Rosebery Avenue .that run through the area (Zhang, 2005).

The main finding of this research is that what we initially thought of as a 'well working' diverse urban area owes at least part of its current structure to what one could see as a degree of economic lack of success Where the City of London, immediately adjacent to Clerkenwell, has developed and redeveloped its

Table 1. Regression analyses between pedestrian movement flow and spatial variables within selected sub-areas

Sub-Areas	No Gates	RATES (Spatial Variables / Mean No Adult Pedestrians)									
		MORNING (9.00-11.30)		LUNCHTIME (12.00-14.00)		AFTERNOON (14.30-17.00)		EVENING (17.00-19.30)		ALL DAY	
		r^2-Int_R3	r^2-MAngDn	r^2 Int_R3	r^2-MAngDn	r^2-Int_R3	r^2-MAngDn	r^2-Int_R3	r^2-MAngDn	r^2-Int_R3	r^2-MAngDn
Observation Area	132	.17	.27	.24	.32	.21	.34	.24	.33	.24	.35
AREA 1.1	30	.52	.55	.70	.70	.67	.63	.59	.58	.72	.72
AREA 1.2	10	.37	.77	.58	.84	.40	.67	.40	.90	.49	.86
AREA 3	29	.73	.72	.75	.58	.74	.56	.72	.77	.82	.77
AREA 4.1	23	.24	.60	.21	.51	.46	.12	.42	.16	.23	.58
AREA 4.2	13	.46	.32	.48	.43	.22	.14	.65	.59	.72	.58
AREA 4.3	6		.78		.59		.69		.74		.83

buildings over the years, and in doing so has re adjusted the alignment of streets, amalgamated blocks and subdivided blocks, and radically changed its structure, the neighboring Clerkenwell area has not done so. Part of it could lie exactly within Clerkenwell administrative location outside the walls of the City of London. However, at the root of this paradox lies its spatial structure that divides the area into a series of different sub-areas poorly related to one another. Although there are major global routes passing through the area – Farringdon Road and Clerkenwell Road for example, (19th century inner city 'bypasses'), these are constructed to take people and traffic through the area on larger scale trips, and poorly related to the neighborhood itself. The effects of restructuring have therefore not gown from the local requirements of the economy of Clerkenwell, but from the larger scale requirements of London as a whole. In this sense the area has remained a marginal area in the larger processes of change in the city as a whole. These are reflected both by the strict localism of pedestrian movement 'correlated' areas. However, it is exactly this failure that seems to be a crucial factor in maintaining Clerkenwell's diversity, in ensuring that it is alive at evenings and during weekends, and in maintaining its local residential, employment and leisure activities and the social and economic networks that these allow.

4. Conclusions

Clerkenwell emerges not an aggregation of similar mono-functional unities, but a complex system of centres and sub-centres of activity. The analysis identified the micro-scale spatial and occupational patterning within Clerkenwell, and drawing on the large-scale analysis of the urban area attempted to describe the complexity of the whole system. The disaggregated line segment model enabled the analysis by disaggregating further real urban flows and revealing real patterns at the scale of line segment. This fine grain of analysis was used to re-evaluate the interdependence between spatial and occupational patterns. What is the larger issue that the study of Clerkenwell suggests? When we consider sustainability an important component must be the stability of a process that will conserve social and economic community structures over time. These structures are strongly related with the spatial structure and how this has been formed and transformed over time. The time factor appears to be essential component to the understanding of the city process. The research suggests that one part of stability lies in exactly the maintenance of a relatively complex and difficult to understand whole composed of relatively easy to understand parts. This dialectic relation between the different scales within which different space use and different social groups occupying space could be the one that should be sought after by urban planners and decision makers. It could be also argued that the perceived risks, expressed both by members of the

public and decision makers regarding a diverse and dense city, based on the negative externalities that occur due to the mixing of different and often conflicting activities within the confined urban environment, could be reduced if their approach incorporates this understanding.

5. Acknowledgements

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6. References

Breheny, M. (1995) *Sustainable Development and Urban Form*. London, Pion

Brindley, T (2003) The social dimension of the urban village – a comparison of models for sustainable development, *Urban Design International* 8: 53-65

Bromley, R., Tallon, A., Thomas, C. (2003) Disaggregating the space-timer layers of city-centre activities and their users, *Environment and Planning A*, 35: 1831-1851

Campbell, K. (1999) Mixed-use city centres *Urban Design Quarterly* 70 April 20-23

Evans, G.L. (2005) Mixed-Use and Urban Sustainability' *Planning in London*, Issue 52, January-March: 43-45

Hillier, B. and J. Hanson (1984). *The Social logic of space*, Cambridge University Press.

Hillier, B., A. Penn, et al. (1993). Natural movement: or configuration and attraction in urban pedestrian movement. *Environment & Planning B: Planning & Design* (20): 29-66.

Hillier, B. (1996). *Space is the Machine*, Cambridge University Press.

Hillier, B. (1996). Cities as movement economies. *Urban Design International* 1: 49-60.

Hillier, B. (2000). Centrality as a process: accounting for attraction inequalities in deformed grids. *Urban Design International* 3(4): 107-127.

Hillier, B and Iida S. (2005) Network effects and psychological effects: a theory of urban movement, *5th International Space Syntax Symposium*, Delft, TU Delft

Jacobs, J. (1961). *The Death and Life of Great American Cities*. London, Penguin Books Ltd.

London Borough Islington (2002). Islington Unitary Development Plan 2002. London.

ODPM (2000) *Our Towns and Cities: The Future - Delivering the Urban Renaissance*. London, Office of the Deputy Prime Minister

ODPM (2004) Consultation *Paper on Planning Policy Statement 1: Creating Sustainable Communities*. Office of the Deputy Prime Minister

Owens, S. (1992). Energy, Environmental Sustainability and Land-Use Planning. *Sustainable development and urban form*. M. J. Breheny. London, Pion.

Penn, A., B. Hillier, et al. (1998).Configurational Modelling of Urban Movement Networks. *Travel Behaviour Research:updating the state of play.* Juan de Dios Ortuzar, D. Heshar and S. Jara-Diaz. Amsterdam, Pergamon press, Elsevier**:** 339-362.

Pink, W. J. (2001). *The history of Clerkenwell by the late William J.Pinks*. London, Francis, Boutle.

Thomas, C.J. and Bromley, D.F. (2000) City-centre Revitalisation: Problems of Fragmentation and Fear in the Evening and Night-Time City, *Urban Studies* 37(8): 1403-29.

Rowley, A. (1996) Mixed-use development: ambiguous concept, simplistic analysis and wishful thinking?' *Planning Practice and Research* 11(1): 87-99.

Space Syntax Laboratory (1997), *A brief lesson in observations*, Space Syntax Laborartory.

Zhang, J (2005) Shaping the pattern: a Historical Perspective on the Interaction between Space and Function in Clekrenwell, 5*th International Space Syntax Symposium*, Delft, TU Delft.