Title: **Decoding urban diversity in a "mixed-use" neighbourhood**

Authors:

Irini Perdikogianni, The Bartlett School of Graduate Studies, UCL
Jo Foord, Cities Institute, London Metropolitan University *and*
Rosita Aiesha, Cities Institute/London Borough of Camden

1. Introduction - Setting the scene

This paper describes a cross-disciplinary approach to the investigation of complex urban areas, notably mixed–use, high density central city neighbourhoods. Nationally and internationally, government policies increasingly promote 'mixed-use' as a sustainable form of urban development (DETR 1998; OPDM 2000, 2004; DTLR, 2002; CEU 2004, UNCED 1992). This notion of mixed use assumes that a socially and economically diverse and dense urban neighbourhood is a viable environmental unit and model for further urban intensification. Though the interdependence of these factors and the perceived overall benefits have been taken for granted *a priori* it could be argued that in some respects they are counterfactual. For example there is longstanding resistance to higher density living in the UK and increasing recognition of the negative impacts of "24 hour" activity. People that live in these neighbourhoods often express complaints about the noise, the smells or rubbish produced by uses like clubs, bars or cafes/restaurants located in their vicinity. This contradiction between policy aspirations and claims, and the expressed concerns of communities, derives from the lack of a systematic and holistic empirical study of city life and location decisions in central neighbourhoods. As Harrison suggests: 'Evidence-based evaluation of urban policy and practice needs to address a number of 'wicked problems' (Harrison 2000 - after Rittel and Webber 1973, Evans 2006). Mixed-use is one such complex "problem".

In particular, there is an absence of a robust methodology that can integrate both the morphological and functional complexities of compact city neighbourhoods. Drawing on this gap in urban studies, the new methodological approach described here aims at building up empirical evidence of these relationships in order to examine the assumptions of mixed use and contribute to the development of evidence-based decision-making tools for planners, designers and other stakeholders in the urban environment. We present the findings of the application of this approach in a case study located in the area of Clerkenwell in London's City Fringe.

The paper opens with an overview of relevant theories developed to describe the role of urban form, land use diversity and social dimensions in urban sustainability, identifying the gap of a more integrated approach. It then describes a cross-disciplinary methodological approach and applies this to a pilot case study.

2. Diversity and Uban Sustainability

It is commonly argued that sustainable urban development should involve a more efficient use of energy (human and other resources), where: ‘a dense integration of residential, employment and supply premises could substantially reduce the use of the car, promote pedestrians and cycling and at the same time contribute to a lively street life with natural, unobtrusive social control’ (Sieverts 2003: 36). Owens (1992) suggests that since cities are major energy consumers, an important determinant of urban sustainability is the distribution of land-uses and their emergent patterns. Many note the importance of planned land-use diversity for developing compact, and therefore sustainable, city environments (Breheny 1995, Campbell 1999, Jacobs 1961). For Jacobs, organic land-use diversity appears to be an essential ingredient of successful urban living, claiming that cities are ‘natural economic generators of [land-use] diversity’ as they create ‘efficient economic pools of use’ (1961). Others emphasise the specific roles of social diversity (Brindley 2003), economic vitality (Porter 1995, Worpole and Greenhalgh 1999), production clusters (Scott 2000, Evans 2004) and governance structures (Polese and Stern 2000, Hawkes 2001).

Historically, there has been a specialized differentiation of labour within cities, while social heterogeneity is considered almost self-evident (Kostof 1991). Access to a variety of people, goods and services is viewed as one of the central assets of successful urbanism. In addition Kostof argues that ‘Cities are places where a certain energized crowding of people takes place’. He stresses that this has nothing to do with overall settlement size or population, but with settlement density (1991).

Labour supply is often cited as the most important factor in business location and the ease of employee and customer access perhaps the key transport consideration (McQuaid 2004). However, whilst transport investment has played a pivotal role in reducing travel-to-work time and improving access to social and leisure amenities, there is little evidence of the reverse effect, encouraging

businesses to locate in transport accessible areas to allow wider labour market participation and reduce travel demand (Breheny 1999). Although urban form has been significantly influenced by transport technologies, cities are also shaped by economic, political and cultural priorities relating to infrastructural investment and lifestyle or workplace preferences (Newman & Kenworthy 2003).

Some studies propose that the degree of choice offered to city–dwellers (in relation to urban amenities and resources) emerges primarily from the physical environment. It is argued that 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). This approach suggests that in an urban system there is an interdependent relationship between urban form and patterns of living. It is proposed that the urban grid itself creates patterns of city life through "configurational inequalities" which in turn produce "attractional inequalities" resulting in patterns of different land-uses (functional space) of different densities. Thus, cities are considered to be a spatial system that creates busy/dense mixed-use and quieter/dispersed mono-use areas identified by their different configurational and functional properties. These spheres of urban spatial configuration are connected through levels of movement within the urban network (see Fig.1, Hillier 1996). In particular a systematic relationship has been claimed between spatial layout and patterns of people's use of *public* space (Hillier and Hansen 1984). Using this approach, urban sustainability becomes a question of density and whether cities should be nucleated or dispersed, concentric or polycentric.

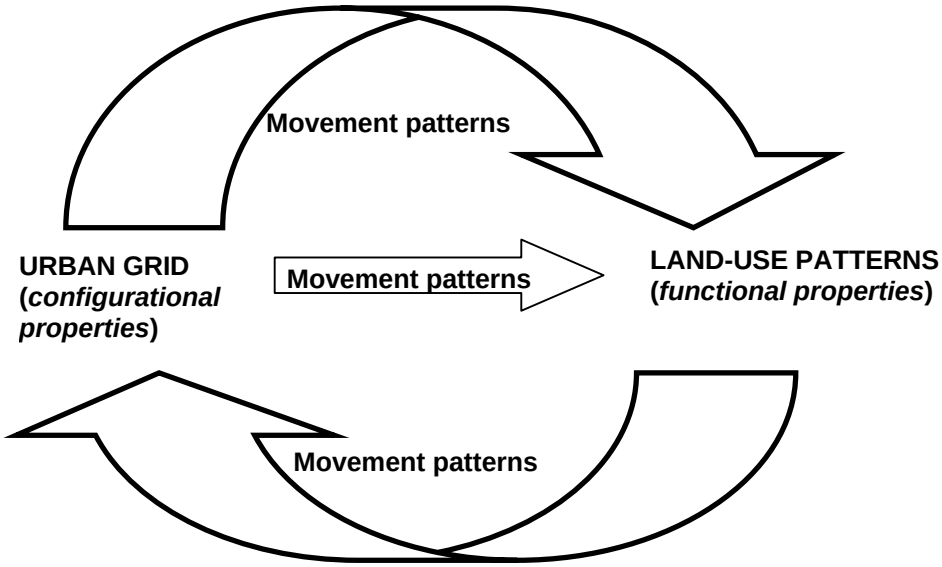


Fig.1 This diagram summarizes the concept articulated by Hillier (1996) that describes urban grid as a system of "configurational inequalities" which generates a system of "attractional inequalities" initiating a feed back process between urban grid and land use patterns with the main medium of movement flows of pedestrians and vehicles (Source: Authors)

Proponents who prioritise the street and its properties in the creation of vibrant and diverse urban environments also see a close association between the physical urban environment and types of social activity. For them street patterns combined with the activities that take place on the street frontage affect the possibility and form of encounters between people (Gehl 2001, Sennett 1994, Jacobs 1961). This interpretation suggests that the growth and dynamism, or the stagnation and decline, of city life is dependent upon the street pattern and its potential to facilitate activity and interaction. The arrangement of streets therefore becomes a necessary condition of successful urban living.

This interpretation has been assimilated into the policy imperatives promoting mixed-use and the compact city (see Fig.2). The extension into the economic/employment sphere is an important aspect of the compact city model, but one largely absent from planning, design and "sustainability" policy.

Concentration and Diversity of Activities		
Vitality	Less need to travel	Local Economy & Clusters
A more secure environment	Less reliance on car	Production chain; Innovation spillovers
More attractive and better quality town centres	More use of and opportunity for public transport	More local employment and services
Economic, social and environmental benefits		

Fig. 2 Advantages of Mixed-Use (Source: adapted by the Authors from DoE, 1995**)**

Moreover, current policies and guidance neither prescribe nor measure the degree or extent of mixed-use and compactness either spatially or demographically. For instance, Rowley highlights the importance of *scale* in achieving mixed-use (1996). Mixed-use varies from the micro to meso level, and at larger and smaller physical scales – town, village, quarter, block or building (Fig 3).

Rowley also identifies key variables in mixed-use, suggesting that the practice is not homogenous and that specific local conditions need to be taken into account. For example, he suggests 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.

Mixed Use/Activities - Continuum

Scales	Form	↑
Level 6	Buildings	Small
Level 5		Large
Level 4	Street blocks or sites	Small
Level 3		Large
Level 2	Areas, districts, neighbourhoods and 'quarters'	Small
Level 1		Large
		↓

Single/Mono-Use Activity

Fig. 3 Mixed-Use Scales (Source: Rowley, 1996b)

Yet, from a different perspective, urban space can be seen as being fundamentally 'socially produced' (Lefebvre 1974). Indeed a fourth pillar of sustainability is now ascribed to "culture" and related governance processes (Hawkes 2001). Here the spatial practices of everyday life are valued as are the ways in which space is conceived and represented by design and policy practitioners (and by the media). For example the practices of city planning and conservation (including governance) and those of building development and design, have impacts on the representation of urban space that directly influence both the physical urban landscape and the lived urban experience. The social production of space, including the negotiations between different stakeholders, is particularly complex in existing urban settlements and in cities where change is incremental and contested. For example, mixed-use development is often proposed for brownfield sites, involving the re-use of existing buildings, a temporal shift in trading hours (including moves towards a "24-hour" city/economy), different patterns of social composition (class, lifestyle, tenure), and new encounters between residents, workers/commuters and visitors. These inter-actions are both dynamic and spatially experienced, but as Lefebvre points out: 'The word user has something vague and vaguely suspect about it. User of what one tends to wonder? The user's space is *lived* - not represented or conceived' (1974: 362).

Despite the apparent desirability (and promotion) of mixed-use diversity, achieving this through urban design and planning policy has proven to be problematic – perhaps not surprisingly if Lefebvre's analysis of space is acknowledged. 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 arise when '24-hour'/night-time activity or other non-compatible activities in mixed or residential areas create disturbance within developments or spill out onto the streets. This is particularly acute where one use/user group comes to dominate a mixed-use area, for example late night clubs and entertainment venues (Thomas and Bromley 2000; Bromley *et al*. 2003). This raises questions as to whether mixed-use is a viable solution for creating places that people would like to work or live within and at what scale it can work.

Our research therefore proposes a re-examination of the relationships between physical, functional and social space. This 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. It therefore demands a new methodological approach that captures the complexity of lived urban spaces.

3. A cross- disciplinary methodological approach to "mixed-use" neighbourhoods

The methodology proposed here focuses on the dynamic link between the physical (urban form), the functional city (land and building uses and economy, infrastructure and movement flows) and the social city (distribution of social and ethnic groups; processes of development, planning and resource allocation; and the everyday experience of people) - see Fig 4. Our approach acknowledges the importance of urban form but unlike studies of urban morphology and spatial systems so far, it incorporates the social city aiming at a synthetic representation of the complexity of cities. A key tool in developing this methodology is a Geographic Information System (GIS) using ArcGIS software. This application allows data and representational layers of city space (physical, functional and social) to be constructed and visualised. It also facilitates relational spatial analysis. The latter eases the interrogation of interdependencies between physical, functional and social processes for the construction and functioning of mixed-use sustainable urban areas.

The methodology focuses on assembling, describing, representing and analysing the multiple aspects of the physical, functional and social city. These can be conceptualised as interdependent layers within the urban system. Representing and analysing an urban area entails a microanalysis of its physical and functional spatial properties (the use of the buildings and land, movement within the

public space of the area) and a synthesis of its social spatial properties (the distribution of socio-economic activities; processes of development, planning and resource allocation; and the lived experience of people and economic activities). By taking space as a common framework, and using a GIS system to create an integrated spatialised database for the study areas, we are bringing together observation-based surveys of land-use, space-use, traffic and pedestrian flow, social surveys of households, businesses and local stakeholders, and data on the policy, planning and development processes. This research is being undertaken at a variety of spatial scales (the study area as a whole, selected sub areas, streets and the individual building or block), and is sensitive to temporal differences in usage. It is also recognised that each factor can be affected by and simultaneously have an effect on any other, both spatially and temporally.

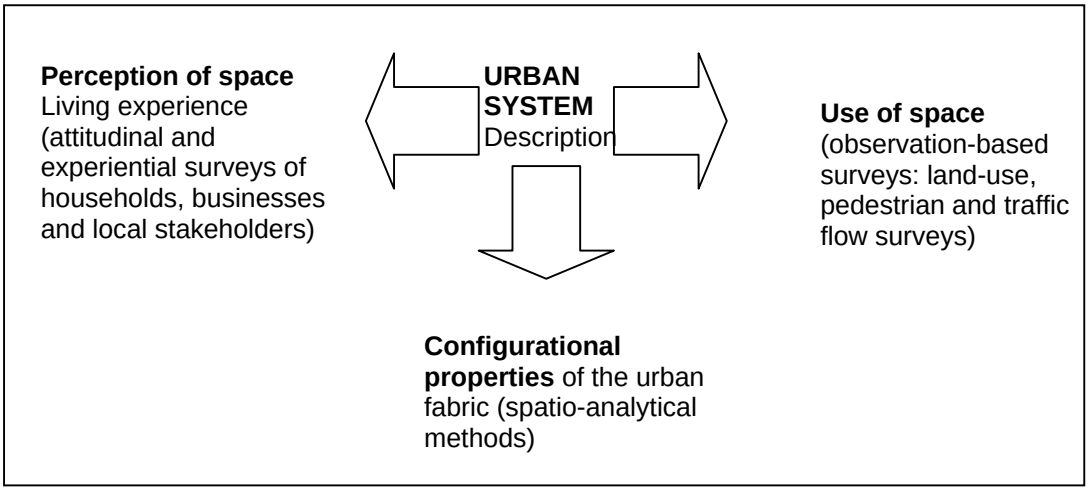


Fig.4 De-coding the urban system: The diagram represents the breadth and width of our methodological approach aiming at capturing the complexities of city creating and functioning processes. (Source: authors)+

A first step in applying this approach was the spatial analysis of the street morphology of the study area for identifying regularities and irregularities in street layout that could account for any observed functional patterns. The analysis is enabled by a spatial model which represents all streets and public spaces as a line matrix of direct access in order to get from every location to every other possible location, following the rule of creating the longest and fewest lines (axial map)[1] (Hillier, 1999). The "axial map" produced is analysed in relation to its "topological" properties by translating the line matrix into a graph and measuring the topological properties of the graph. All the (axial) lines are differentiated or "weighted" only in relation with their position in the global network. The measure of integration quantifies the syntactic properties of (axial) lines by measuring their mean topological

[1] The axial map is based on Ordnance Survey Master Map Data courtesy of Ordnance Survey for the EPSRC funded project: VivaCity2020.

distance (depth) from every other (axial) line considering the (urban) system as a whole[2]. This model and the abstract spatial descriptions of the urban system form the basis of Space Syntax research. The axial map produced for the study area took into account the surrounding city environment with an approximate 3 km radius (See Fig 5).

Fig.5 The axial map of Clerkenwell case study (in grey) embedded within a 3km radius surrounding city. All streets and public spaces are represented as a line matrix of direct access in order to get from every location to every other possible location and make all the connections. All the axial lines are differentiated or "weighted" only in relation with their position in the global network. This figure colours 2% of the most integrated lines as thick black lines and 28% of the least integrated lines as dotted lines and the rest as thin black lines.

The theoretical background in this field of research suggests that the configurational properties of the street system have an effect on how different land and building uses are assimilated within urban system initiating a feed back process from land uses to the street system as well - see Fig 2. Uses like retail or small restaurants seem to occupy strategic locations that have easy access from everywhere, and thus are well connected with the rest of the system (these are on streets with large global and local integration values). This is because they seek to benefit from passers-by. People tend to move on streets that are well connected to the rest of the street system (small mean distance from all other

[2] Global integration (or radius n integration, INT R(N) measures the mean depth (distance) of all axial lines in a plan from the line in question and then normalises this for the number of lines that are present in the plan. Local integration (or integration radius 3, INT R (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)

streets) which indicates a high integration value. Other uses (e.g. residential) benefit from more privacy so they tend to form quieter zones in more secluded areas (streets with small global or local integration values). However, the presence of these uses itself (e.g retail,restaurants,residences) in particular areas either attracts or restricts more pedestrian activity. This process however, reinforces the particular character of these areas - the busy areas become busier and the quiet ones become quieter. The main medium in this process is pedestrian movement patterns. However, using the “axial” model to represent urban space, previous empirical findings have shown that a substantial proportion of people movement patterns in cities are generated by the structure of the urban grid itself (Hillier, Penn et al. 1993).

In this approach therefore, we follow a comparative statistical analysis of primary data on pedestrian and vehicles movement flows and land uses within the area with topological properties (syntactical values) of the streets considering the urban area as a spatial network. The land use data gathered through on site observation inform us about the functional identity of the area and any “attractional inequalities” that may exist.

The pedestrians and vehicles movement observation based surveys were conducted in a sub-area within the study area. 213 pre-defined locations were observed by a group of 16 trained observers.. Pedestrians passing by each location for 5 minute period were counted. The locations on main streets were observed for 2.5 mins. Pedestrians were classified as *locals*, *working within the area* and *tourists* based on their dress code, distinguishing between *men* and *women.* Overall, pedestrians and vehicles were observed periodically in pre-decided nine time slots between 8 a.m. and 8 p.m. during one weekday and one weekend day. Vehicles were counted for the same locations and during the same time periods. They were classified as *private cars, motorcycles, bicycles, goods vehicles, taxis and buses.* For the land-use survey, the study area was divided into 12 sub-areas and data collected through observation for each building and open space by a group of 7 trained observers. Overall, uses of the ground floor, first floor, the main use above first floor and the number of floors for all 3618 premises were recorded. Some additional information on the names and the opening hours of the retail and commercial premises were also recorded for capturing the temporal aspect of city life. The

land-uses were classified using an adaptation of the National Land-use Database (NLUD) Classification.[3] Detailed multi-level land-use maps were created for the study area.

To capture the experiences of those living or working in this mixed-use environment, the planning and the policy context a qualitative approach has been adopted. In order to begin to understand the social environment of the case study area a number of focus groups were undertaken with local residents, supplemented by face-to-face interviews with the key actors in the local community (including representatives of community groups, local authority officers, key business leaders, faith groups etc). Secondary data sources, notably planning applications/permissions and geo-coded census/ demographic, crime and available environmental data were collated and manipulated for GIS analysis.

A structured postal business questionnaire survey of businesses (n=700) was undertaken and at the same time, a face-to-face residential questionnaire survey. Each research instrument was used to assemble socio-economic and policy data that contributes to the analysis of the impact of mixed-use on its different users and occupiers. This includes capturing people's (business and residential users) perceptions of the positive and negative aspects of where they live or work. The selection of locations for administering the household and business surveys was based on the axial model targeting locations with different configurational properties. GIS representations of this data aimed at identifying significant interdependencies between the "social realm" and the spatial morphology. GIS therefore enabled identifying patterns of response for different users and if their perceptions differ according to where they are situated in the scale and morphology of mixed-use building/block, neighbourhood and area types.

The Household Survey uses a structured questionnaire administered by researchers, with 100 closed and open questions and is analysed using the standard social survey software, SPSS. The design of the questionnaire was informed by the results of the focus groups and key informant interviews as well as previous surveys in this field (LSE 2005, DETR 2001). The targeting of households for the survey has been informed by the land-use mapping and sub-area selection based on the axial map from which functional and configurationally patterns can be observed, and mixed and mono-use areas

[3] NLUD Classification Version 3.2

selected. This means that the household sampling method captures both social and land-use diversity. This sub-area sampling method will enable us to see if there are different perceptions within locations that demonstrate different degrees of mixed-use/mono-use. In addition, the household survey strategy allows us to investigate the importance of scale within the case study area. For example how do experiences of mixed use vary from building to street to area level and does this create greater diversity on certain streets and in particular sub-areas.

The Business Survey uses a self-administered structured questionnaire, with 50 closed and open questions and is also being analysed using SPSS. The purpose of this survey was to understand how respondent firms interact within the local area (supply/market networks, location factors, type of building, other occupiers/users), as well as capture views about the local business and residential environment. The sample was drawn from a database of businesses registered with the local Chamber of Commerce. This was supplemented with secondary data on employment and firms from national (Annual Business Inquiry) and Trends Business Research (TBR) datasets. The latter has been provided by GLA Economics and includes more detailed firm data at the small and micro-firm level - particularly prevalent in this local economy. This strategy has captured evidence of business clustering, both spatially and by sector/sub-sector, and of the positive and negative aspects of trading from within a mixed-use location. Further analysis of the spatial relationships and interdependencies between business activity and spatial morphology will be possible using the GIS tool. Understanding these relationships and interdependencies have important policy and planning implications related to local economic development, premises needs and related infrastructure planning (Evans 2004).

The Householder and Business Surveys capture the negative and positive effects of mixed-use living and working. They also document the temporal and spatial activity structures of the case study area. Good neighbours who behave with consideration for others are key to the success of mixed use development in a compact, dense urban environment. However, perceptions of what constitutes a good neighbour, for example, may depend on who lives next door, or the types of use (business or residential). Not all neighbours are perceived to be “good” neighbours. For example a business (office) use next door may not have the same negative implications as a restaurant or bar or shop. The data from the surveys is to be used to assess whether there are differences in perceptions at

different scales: for example, next door (both horizontal and vertical), street and area levels and whether mixed use create different sets of problems at each scale. Specific issues are also raised by this assessment, such as building regulations around sound-proofing, fire/health & safety and planning use-class classification (Evans 2005).

In the case study area therefore, the spatial reference works at two different, though related levels: first with the documentation and description of the urban system of the area itself. From this the mixture of different land-uses and movement within the urban system can be identified as well as some of the spatial mechanisms that generate and sustain diverse urban forms. Second the locational analysis of the attitudinal and experiential surveys enable mapping of the perceptions and living experience in a mixed-use environment with reference to particular spatial and functional features at the building, street and neighbourhood scales.

4. Case study Clerkenwell - Pilot findings

In order to test this approach a historically, mixed-use "urban village" - Clerkenwell in London's 'City Fringe' - was chosen as the first case study. This area had been selected as an archetypal mixed-use neighbourhood on the edge of the Central Business District (CBD) of London. Clerkenwell is considered to be one of six 'Urban Village Precedents' in the UK, because of its 'form of streets, position of public buildings, urban industries and shop fronts' (Aldous 1992: 93). The area maintains many Victorian and earlier 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. Its character is considered valuable enough to be protected by the local planning system through Conservation Area status (LB Islington 2002). The cross-disciplinary approach was used to investigate what the relation may be between its diverse character and its viability as an area which is adjacent to one of the most concentrated and economically powerful areas - the City of London. The complexity of the built environment and of the socio-economic processes that create city-life (historically and contemporary) justified this selection.

The map of land-uses for the ground floor use for all premises and open space showed that although there are a variety of uses, there is an underlying structure in the way that these are assimilated within

the overall pattern. Clearly there is a spatial separation of residential and more mixed-use environments. There are mono-functional residential sub-areas in the north of the study area with a limited range of other uses (newsagents, local shops or pubs) often located on street corners (see Fig.6). These business uses are identified either as retail, services or leisure and entertainment. There are mixed-functional sub-areas in the southern sector of the case study area with a higher number of offices and retail uses and a significant number of other, more diverse uses such as community facilities, services, leisure and entertainment as well as residential premises.

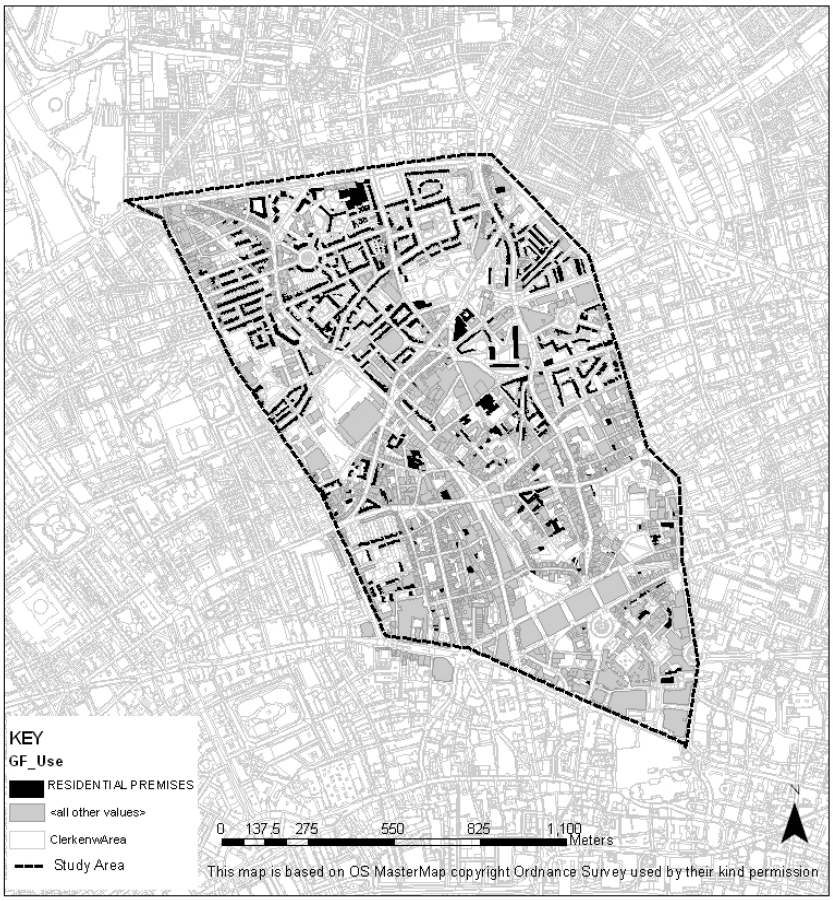


Fig 6 The observation-based land use survey shows a spatial separation of residential located in the north of the surveyed area and more mixed-use environments in the south.

This structural separation of different uses can also be observed at the scale of a smaller area. For example Exmouth Market, a semi-pedestrianized street which houses different uses such as retail and catering facilities (i.e. restaurants, cafes and sandwich bars) is located next to a street dominated by housing blocks (largely social/rented), as well as offices. This mix of different uses is not arbitrary, but one needs to change direction to find different spatial qualities. The spatial model used here captures this by attributing different topological values for every change of direction. The same pattern

of spatial separation between residential and more diverse environments is reinforced by the density of pedestrian and traffic flows observed in these environments. In this case by simply overlaying the findings of both observation based occupational surveys, with the help of GIS system, one can easily observe a large number of people (total daily mean per hour adult flow n=1635) moving along the east side of Exmouth Market with a high proportion of retail premises (in light grey), while the north end of Farringdon Road which houses a high proportion of residential premises (in black), attracts a smaller number of pedestrians (daily mean per hour adult flow n= 467). In Fig 7 it is clear that in order to get from Exmouth Market to Farringdon Road you need to change your direction once. In axial lines terms, those two streets are one axial line (or step) away. So in other words, residential and retail uses co-exist in Clerkenwell however they are located one step away.

Fig 7. Exmouth Market Area. The 10% of the most integrated lines if analysed at the radius N represented by thick black lines houses a big number of catering (grey) and retail (light grey) and attract a big number of pedestrians

The preliminary analysis of pedestrian movement flows for 132 out of 213 locations suggests that Clerkenwell is made up of a combination of highly used and less used spaces with the strong positive attractor of Farringdon Underground (tube) station. The four busiest locations (daily mean per hour n>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 Street, South Kensington Museum quarter and Brompton Road - Penn et al, 1998), the data for Clerkenwell is in a much narrower band and so has much less variation. The daily mean per hour (n= 386) compares with an average of 224 for London overall.

Movement rates are also highly time dependent. They vary considerably throughout the day and for different days of the week. The frequency distribution plot of pedestrian movement for 132 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. Movement rates are different during one working day and on Saturday or Sunday as well.

A regression analysis between syntactical values of the produced axial model of Clerkenwell and data on pedestrian movement flow within its environment suggested that what we thought to be one urban entity called “Clerkenwell”, emerged as a complex system of centres and sub-centres of activity. This covered part or all of four administrative wards in two local authorities (LBs Camden and Islington), and bordering a third, the City of London. The analysis manifests that the structure itself splits the area into five 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 (Figure 9). Drawing on previous studies that suggested local integration (IntR(3), as a good predictor of pedestrian movement (Penn et al. 1998), the study correlated this syntactic measure with the Daily Mean flow of moving adults per hour. The weakness of the correlation is highlighted by the r-squared value of 0.244. Despite the untidy shape of the scattergram, the analysis showed that it contained sets of points (each point represents a specific location) suggesting different regression lines, indicating the existence of different sub-areas. Thus, with a method that was developed in a previous empirical study on the City of London, the analysis breaks up the scattergram into its component scattergrams, representing sub-areas, but by holding the axes steady so that different areas can be seen in the same frame (Hiilier, Penn et al. 1993). The identified sub-areas can be seen in Fig 8.

Fig 8. The identified sub-areas within the study area in Clerkenwell as emerged from a correlation between pedestrian movement flow and syntactic properties of the axial model

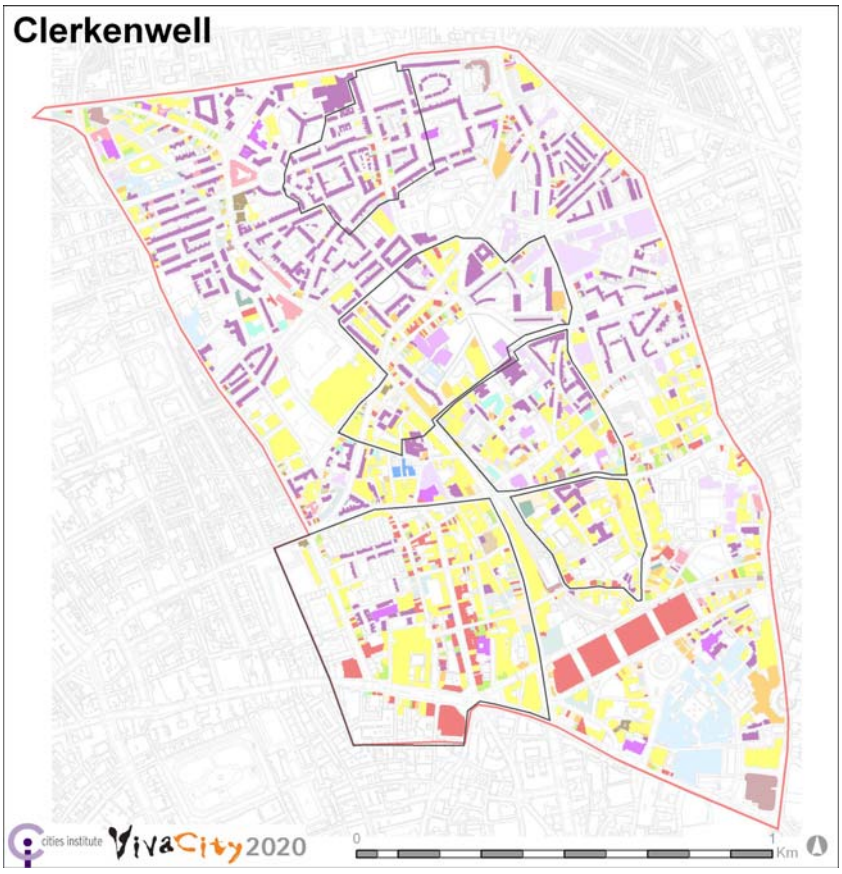


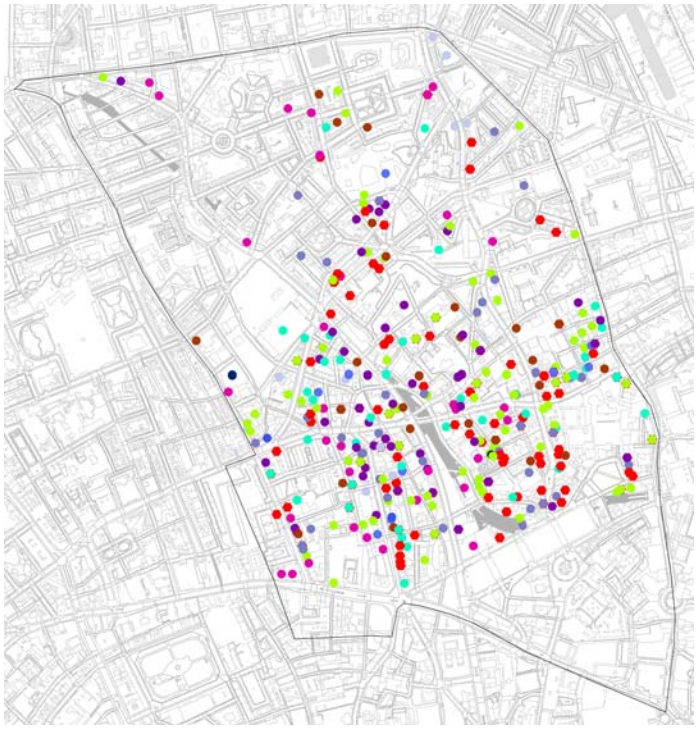
Fig 9. Sub-areas delineated and overlaid with ground floor land-use
Mastermap/POI © Crown Copyright 2007. An Ordnance Survey/EDINA supplied service

The presence of many sub-areas within its system is also implied by the configurational analysis. The latter suggested that within the area many streets-lines are highlighted as local integrators. For example, when the area was analysed as an 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 Roseberry 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 core.

This spatial structure divides the area into a series of different sub-areas poorly related to one another. Although there are major 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 journeys, but are not related to the neighbourhood itself. The effects of restructuring have therefore not grown 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 generally. These are reflected both by the strict localism of pedestrian movement “correlated” areas. However, the structure should be conceived as a dynamic product of the historical process during which this urban environment evolved.

Economic diversity and mixed-use

The relationship between land-use, pedestrian movement and business activity is therefore of interest. So too is the relationship between the density of activity and the potential for the birth of new firms. The policy assumptions are that new firms are more likely to emerge in areas of intense activity and mixed land-use. Detailed geo-coded data (above) on commercial and business activity has been mapped as represented in Figs 10a-d below. The creative industries and residual manufacturing in this traditional metalwork/jewellery and print & publishing quarter are both co-located and cluster together with property (inc. architecture/design) and a concentration of catering and hospitality outlets, including night-time club venues.

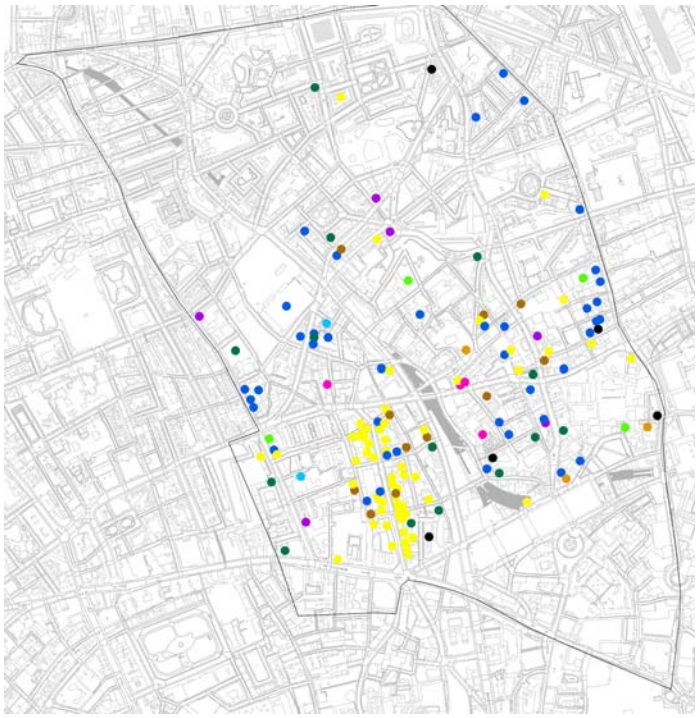


KEY

CREATIVE INDUSTRIES

- Advertising
- Architecture
- Art and Antiques
- Crafts
- Designer Fashion
- Fashion
- Film
- Furniture and Interiors
- Games and Software
- Music and Visual Arts
- Publishing
- Radio and TV

Fig 10a Creative Industries



KEY

MANUFACTURING INDUSTRIES

- Food Products
- Textiles and Textile Products
- Wood and Wood Products
- Printing
- Reproduction of Recorded Media
- Chemicals and Chemical Products
- Rubber and Plastics
- Basic Metals
- Machinery and Equipment
- Electrical and Optical Equipment
- Furniture
- Jewellery and Related

Fig 10b Manufacturing Industries, including Jewellery

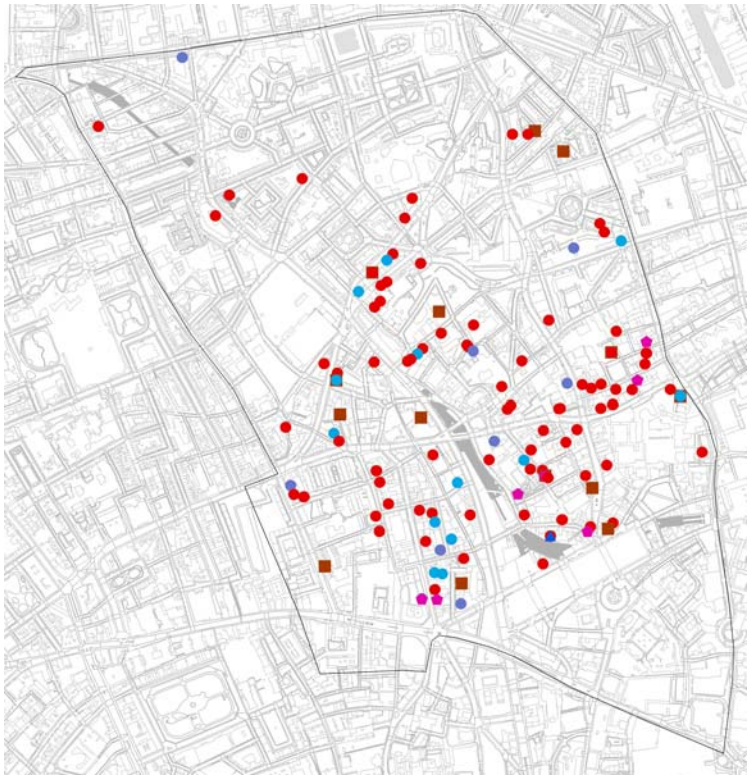


Fig 10c Property Sector, including Architecture

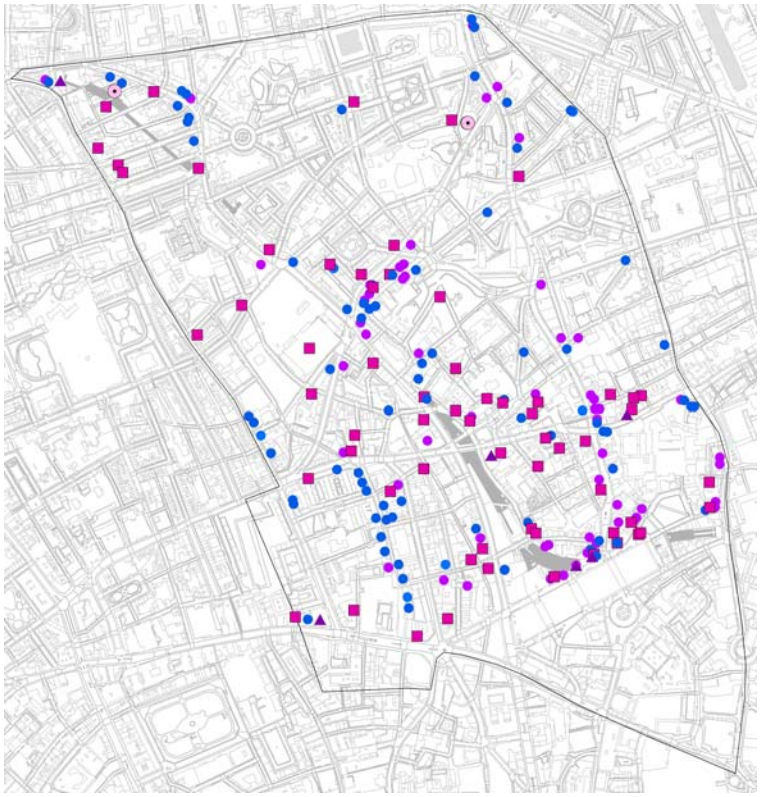


Fig 10d. “Creative Milieu” - Leisure and Hospitality sectors

The “buzz” of an area therefore combines to produce benefits for residents, workers and visitors alike. This is most apparent where people live within close proximity to where they work. From a vox pop survey of visitors to the first London Architecture Biennale held in Clerkenwell in 2004 (Evans and Aiesha, 2006), 70% of respondents were local residents (Fig 11).

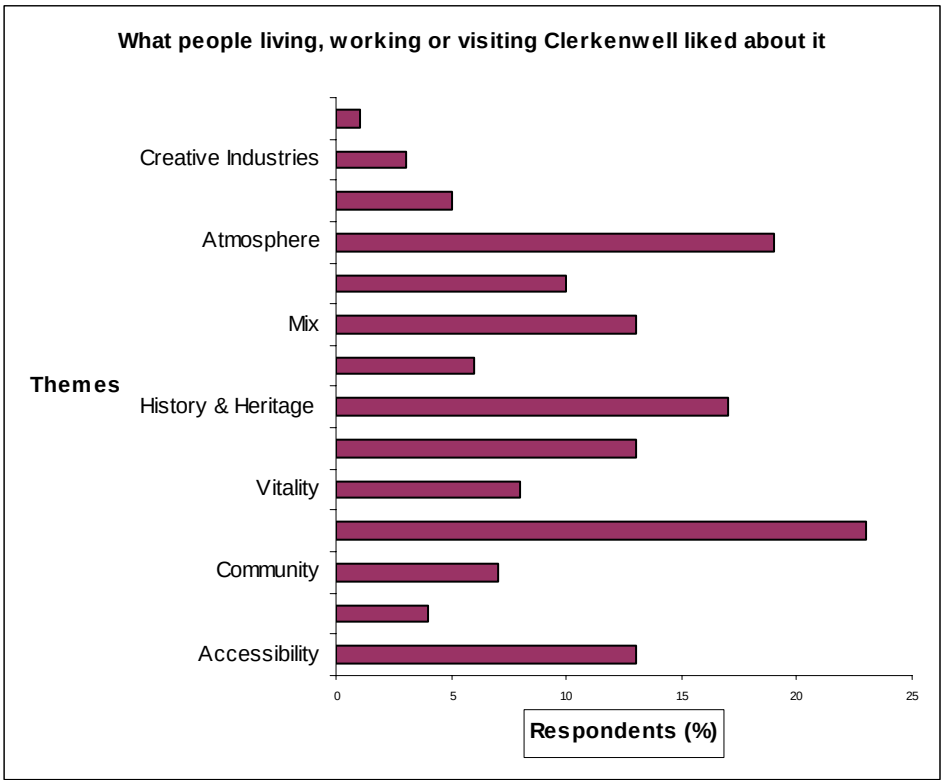


Fig 11: Survey of Visitors to LAB 2004 (Evans and Aiesha 2006)

Multi-clustering also occurs where common conditions serve multiple firm and economic activity needs, notably connectivity (public transport, pedestrian access) and affordability (Fig 12), e.g. advanced producer firms such as law, advertising and architects moving from higher rental areas e.g. West End.

Also,the availability of ancillary services (e.g. print servicing design firms, hospitality) and networks (tacit knowledge exchange, social/lifestyle working). For example a specialist probate law firm moving from W1 to Clerkenwell for proximity to the Metropolitan Archives, and the opportunity for a mixed-use office (first and second floor)/art gallery (ground floor) development.

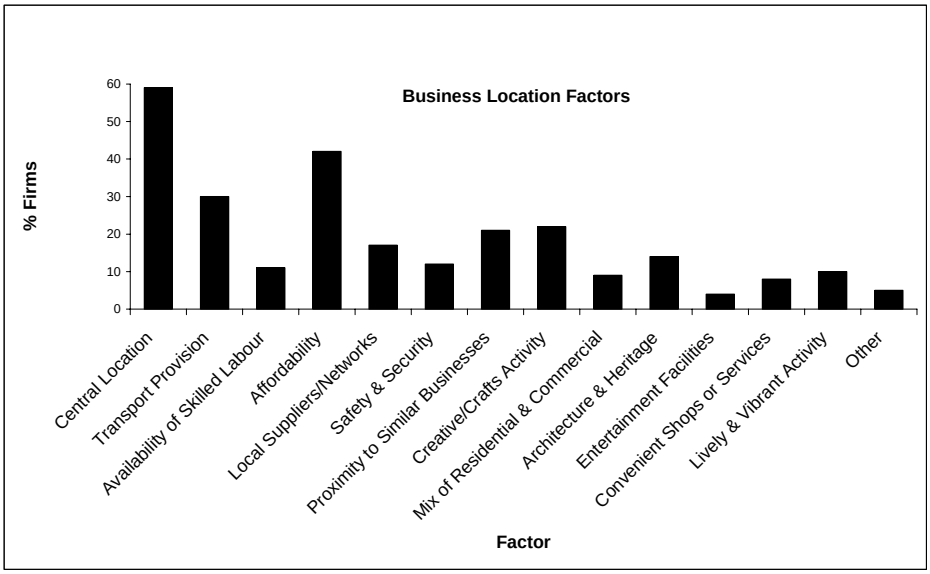


Fig 12: Factors ranked as important for Local Businesses

The clustering of firms also reflects the patterns of diversity in land and buildings use (and re-use, i.e. light industrial) and pedestrian movement. Land use varies most when business activity is highly clustered and pedestrian movement is highest in areas of commercial activity. However data on firm births shows that whereas some births have taken place in areas of existing business clusters, new enterprises are also being established on the edges of activity (Fig 13).

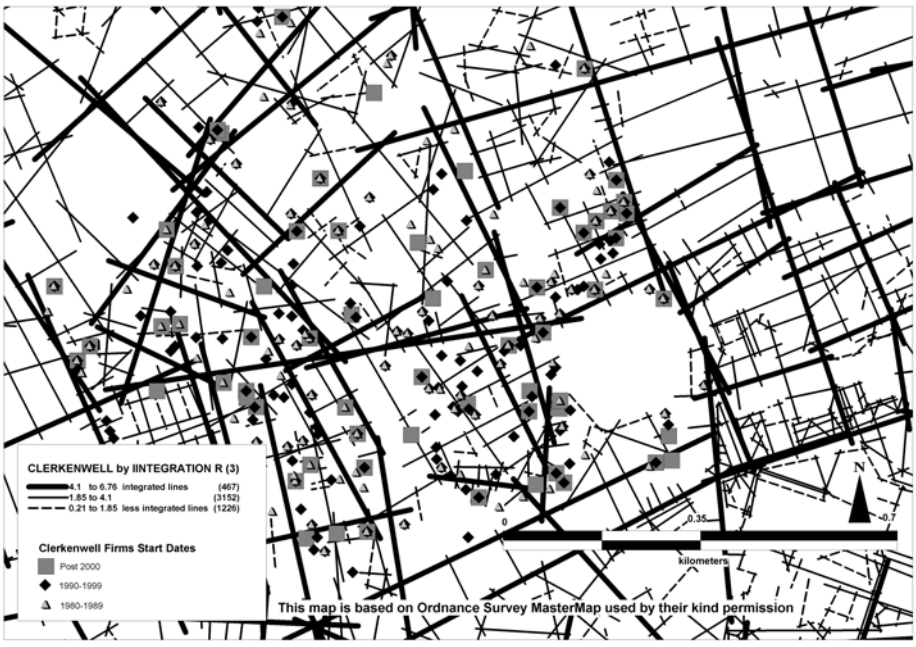


Fig 13. Firm start dates within Clerkenwell overlaid on the axial map of the area. The 10% of the most integrated lines are represented by thick black lines and the 25% of the least integrated lines as dotted lines. (Firms Data Source: ABI, 2005)

Household and Business surveys

Analysis of the Household and Business Survey data (using SPSS) has found that respondents are trading factors against each other in their assessments of mixed use/central city environments (i.e. dwelling type, land-use mix, location, provision of additional security and public transport networks). Some factors however were significant determinants in at least some of respondents' choices. The analysis suggests that the proximity of facilities and activities offered by the central location is a more important pull factor for both residential and business occupiers' location choices than land-use mix. For those respondents who did express a positive preference for locating in mixed-use neighbourhoods, they did so principally reasons of high levels of amenity, whilst from the perspective of the home itself - interior design and facilities, as well as "view" and access ranked highly (Fig. 14).

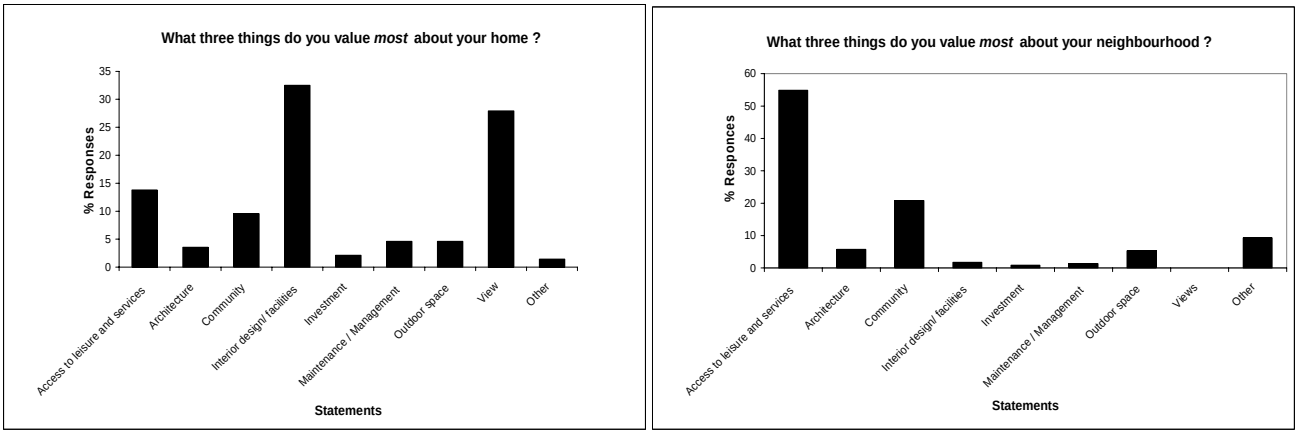


Fig 14: Household Respondents "Most valued" - Home and Neighbourhood

Negative impacts also referred to interior design and facilities (including internal access, walkways etc) which also highlights dissatisfaction with council and other rental properties which could not be adapted to occupant's changing needs and preferences, in contrast to owner occupiers. Noise pollution was also a common complaint, with music as well as construction noise the most frequent problem reported to the council environmental health office. The worst neighbourhood problem however was anti-social behaviour - notably litter (personal, commercial), street crime/vandalism, as well as poor maintenance and management of public space (Fig 15).

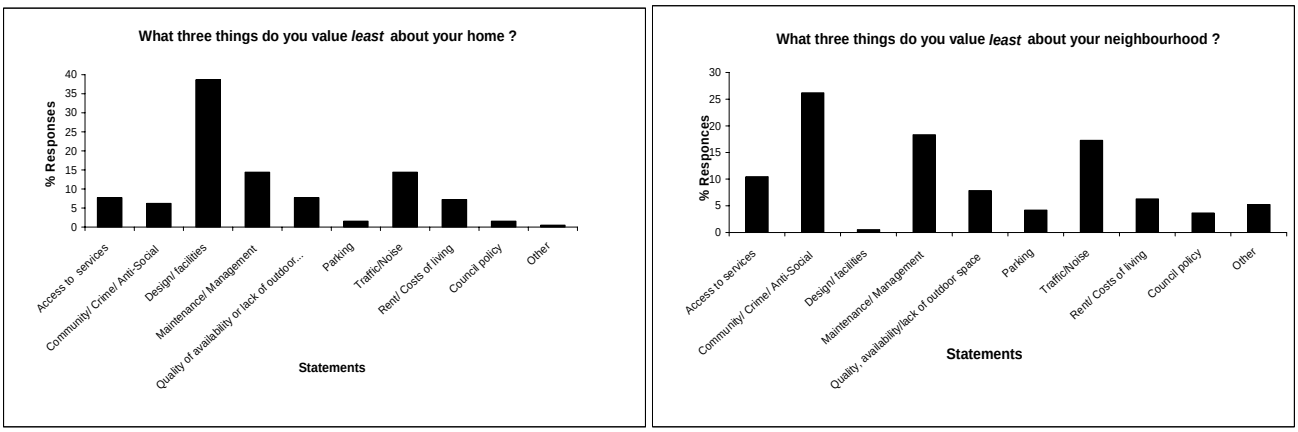


Fig 15: Household Respondents "Least valued" - Home and Neighbourhood

The number one problem for local businesses was also litter, as well as noise and anti-social behaviour, but parking/loading access was a particular constraint to firms accessing supplies and customers (Fig 16). Security was also a problem for businesses - whilst vertical mixed-use afforded some reduction in opportunities for burglars, shared entrances also provided a weak link with uncontrolled access to ground level doors (see Crime - below). Some firms with ground floor accommodation were also exposed in terms of open plan and large glass windows to their offices providing easy viewing of interior and expensive equipment.

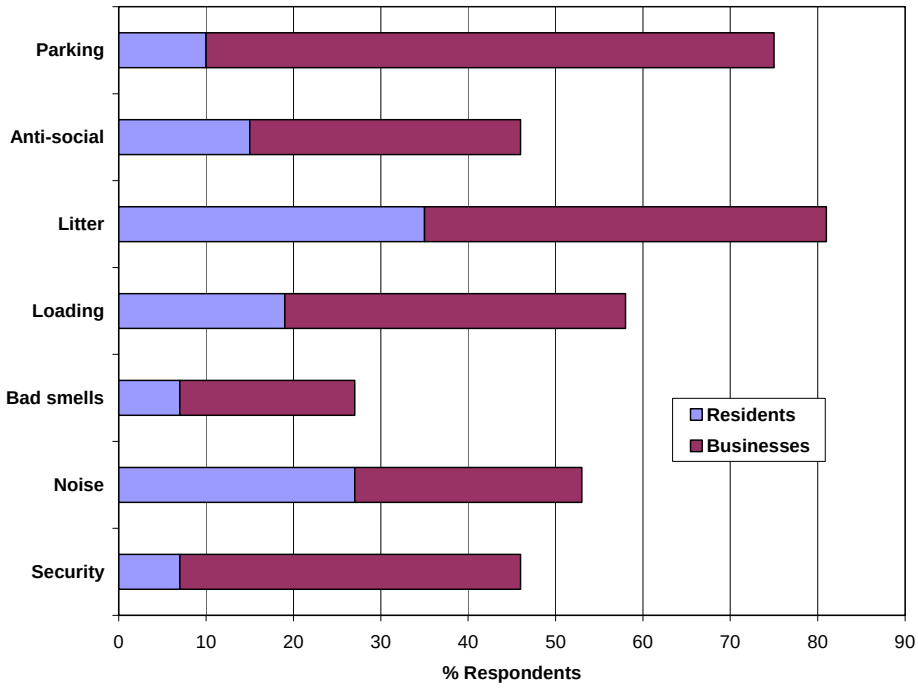


Fig 16: Problems of Mixed-Use Activities - Residents and Businesses

Our analysis also suggests that mixed-use is perceived to occur to a greater extent at the neighbourhood scale and to a lesser extent at building level. A significant proportion, over 80% of residents claimed to live in a mixed-use neighbourhood but with only 36% living within a mixed-use *building*. In addition, business users reported locating in areas with greater horizontal *commercial* land-use diversity. Though diverse, such areas had limited residential use. Furthermore, a large portion, over 80% of business occupiers reported a mix of uses within their building, but very few of them, under 20%, had a residential component within the same building. Most of the other occupants were office, retail or catering-based. This reflects the patterns of separation between residential and commercial activity found in the land-use surveys both at the scale of the study area and the street.

There was found to be a hierarchy of activities which both business and household residents found of particular value. Proximity to shops, banks and bars were of highest priority to business, but for residents the location of health facilities and parks/recreation were considered more important than leisure and bars, although they did rank restaurants more highly (Table 1).

Table 1. Activities and amenities ranked as important by residents and businesses

Type of Activity Valued	Business occupiers %	Residents %
Shops (e.g. convenience, Post Office)	96	80
Bank or Building Society	81	13
Gym or Leisure facility	16	25
Health practice (e.g. GP, dentist)	14	77
Restaurant/cafes	77	60
Park/Playground	28	62
Library	18	49
Art gallery or Museum	20	46
Pubs/bars	80	51
Nightclub	14	13

Negative externalities are more likely to be perceived when they occur at the level of the building rather than at the neighbourhood scale. In addition, perceptions of potential externalities are intimately linked to perceptions of the presence of people associated with specific uses - for example customers of pubs or clubs were viewed more negatively than workers in an office. Likewise respondents' reactions to the amenity value of different land-uses reflected their perceptions of the types of users. Consequently the amenity value of a pub was lower than the amenity value of retail outlets. The preliminary results also show that noise, poor litter/collection service, and parking problems are the three main externalities cited by both residents and business occupiers throughout the case study

area. However, despite these negative externalities, respondents seem to be trading these off against what they perceive as more positive attributes (i.e. a central location and access to well connected bus/tube service).

Crime

Crime, and the fear of crime, was also an issue but moreso “anti-social behaviour” (Household Survey above). The partial permeability of streets such as Exmouth Market did make it vulnerable to criminal activity (street and vehicle crime - Figs 17 and 18). This is evident from reported crime data provided by the Metropolitan Police for a 2 and a half year period, with hotspots around Exmouth Market for vehicle crime (car damage and theft, including bike theft), robbery (snatch theft and personal robbery), as well as commercial burglary. Street and vehicle crime is also concentrated in areas which lack natural surveillance on the edge of the mixed-use area - mainly in mono-use residential and/or office/institutional areas with wide roads/pavements and a lack of ground floor windows.

Office burglary was not surprisingly concentrated in areas of opportunity, but also in quieter areas on the fringe of the higher density areas, where residential burglary was also highest (Fig 17). Street and vehicle crime was also associated with evening and social activity concentrated around restaurant, pub and club venues, with bike theft particularly prevalent around semi-pedestrianised streets that also lacked any secure bike parking facilities.

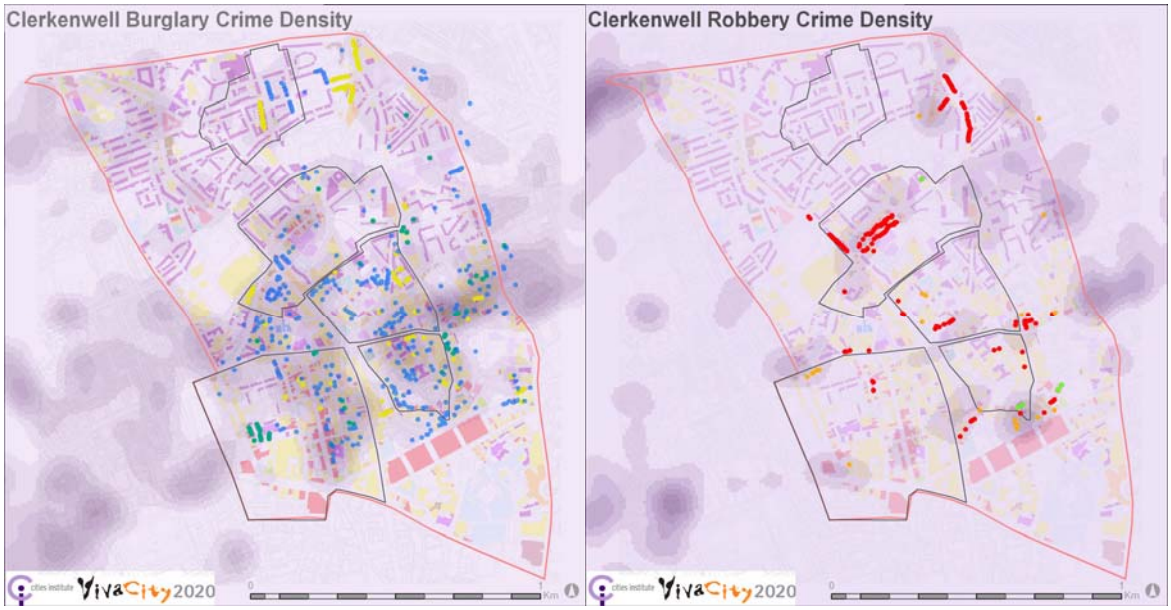


Fig 17: Recorded Crime - Burglary and Offices/Services; Street Robbery and Cafes/Restaurants, Pubs & Clubs

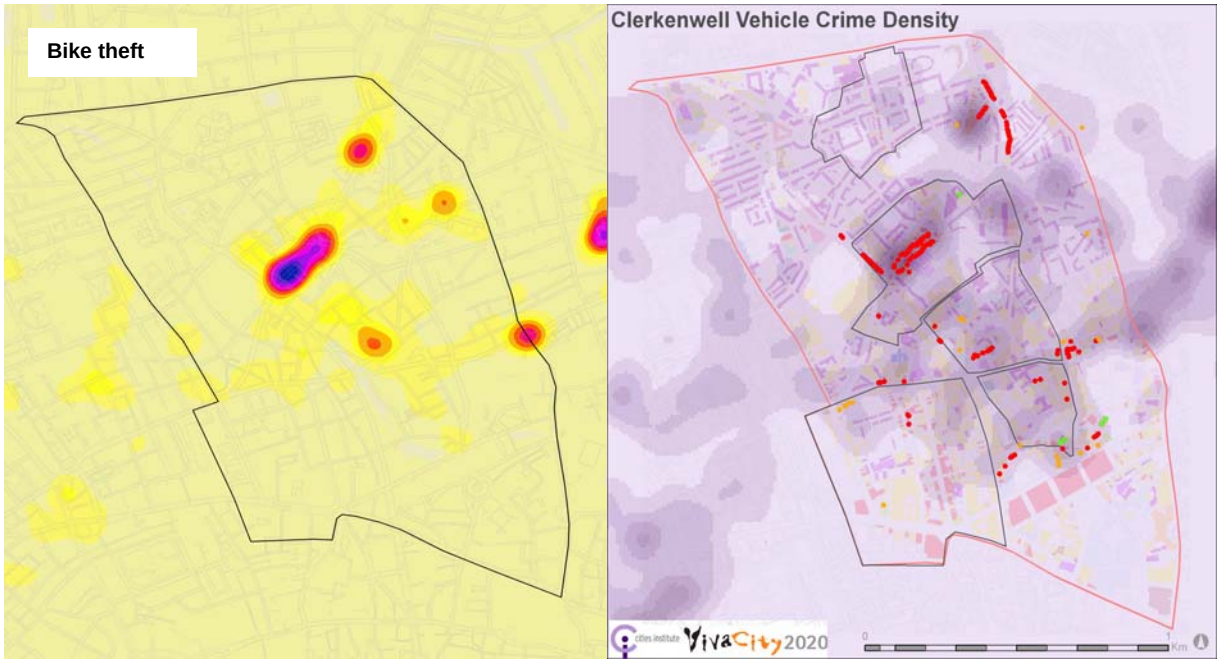


Fig 18: Recorded Crime - Bike theft; Vehicle damage/theft and cafes/restaurants, pubs & clubs

5. Conclusions

The grounded multivariate methodological approach adopted in this research, and preliminary results from the pilot case study, suggests that by generating new knowledge of the range of interactions that take place in mixed-use neighbourhoods, the concerns that different stakeholders express can be addressed and contextualised spatially and morphologically. The Household and Business surveys reveal evidence of the negative and positive externalities that influence both resident and business occupiers' experiences of dense/diverse land-use areas. The analysis enabled us to conclude that the notion of a successful diverse urban environment seems to bear a dynamic relation between spatial, occupational patterns and individual/group behaviour and aspirations. The correlative analysis between spatial measures and movement flows showed us that Clerkenwell's urban structure forms a fragmented system of different sub-areas. 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 areas as a whole.

The analysis of all available data highlights the *scale* - from the micro to macro - at which the city operates. This research suggests that one key to understand and ultimately achieve a sustainable city

is to explore the dialectic relation between the different scales within which the mixing of uses occurs. It could be also argued that the perceived risks, expressed both by residents and decisions-makers regarding a diverse and dense city, could be mitigated and reduced if the approach to development, change-of-use and amenity/infrastructure planning incorporates this understanding and measures "urban carrying capacity" more comprehensively and inclusively.

One of the outcomes of this research is the production of *Knowledge Units* - comprising primary and secondary databases, qualitative case studies, GIS-based tools and techniques focused around high density, compact city living. The methods and tools arising may ensure that supporting policy guidance such as Planning Policy Statements (PPS), Supplementary Planning and Design Guidance (SPD, SDG) and Design Codes will reflect the complexity and inter-actions at differing scales and between the factors at play. These will need to be practical enough for appropriate use at the regional, sub-regional and local level by town planners, urban designers and the development ndustry, to better engage key stakeholder groups and thereby support sustainable decision-making and improve the quality of urban living for incumbent and new communities.

Acknowledgments:

This paper draws on research undertaken as part of the *Vivacity 2020* project (2003-8 www.vivacity2020.org), under the EPSRC Sustainable Urban Environment (SUE) programme. This has investigated the factors that contribute to sustainability in high density, compact inner city areas, and in particular, the interrelationships between economic, social and land-use diversity in mixed-use neighbourhoods. The research is being carried out in case study locations in city centre/fringe areas of London, Manchester and Sheffield.

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