Abstract

This paper describes an experimental method that has been developed to investigate the relationship between spatial preference (in relation to commercial real estate occupation) and spatial configuration. Traditionally, the pursuit of real estate economics has been supply driven, reliant on the rational assumptions of neo classical economic analysis. Furthermore, consumer behaviour is typically an implicit assumption rather than explicit variable in traditional economic analysis. This is because it has been difficult to reveal the characteristics of economic demand (the subjective behaviour of real life participants in the urban land transaction process) and its interaction with the urban environment. In response, the method demonstrated in this paper, and its initial findings, reveals how the human interaction with space (its behavioural characteristics and transactional dialogue), can be explicitly analysed, visualised and combined in order to address this deficit. Findings (based on an initial examination in the city of Leeds in the UK) confirm a relationship between urban configuration and spatial preference, and that this is variable dependent on the use class of commercial property under appraisal.

Keywords

Commercial real estate, urban land economics, spatial preference, urban configuration, consumer behaviour.
1. Introduction and Theoretical Argument

 Certain cities are getting smarter, bigger and denser, by 2050 the World Health Organisation estimates that 7 out of 10 people will be city dwellers (WHO, 2014). At the same time Beauregard (2003), Oswald and Reinerts (2006) and Schilling and Logan (2008) demonstrate that other cities are contracting (see the shrinking cities phenomenon in Eastern Europe and the rust belt in North America). These dynamic shifts in population and the consequent variable demand for space in cities have made it imperative to maximise urban resources. This puts pressure on urban decision makers with regard to land use allocation and provision. Indeed, a recent RTPI report (2014, p.35) claims that urban decision making,

 ‘Is about appreciating and anticipating how different policies and decisions might interact over different pieces of land, and incorporating this intelligence into decision making’

 A central component towards this end is anticipating and revealing where, why and how potential urban consumers make their property location decisions. Unfortunately, the traditional pursuit of urban land economics (and to a certain extent urban planning) have been supply driven, ignoring the suboptimal quality of human demand behaviour. The result of supply led development is the potential location of property in areas where urban consumers don’t need it. Therefore, the challenge for urban practitioners lies in first of all developing theories and methods that explicitly engage with human decision making and then grounding this transaction in the built environment. The authors take up this challenge by demonstrating a simple method that reveals the relationship between commercial real estate spatial preference and urban configuration in the city of Leeds. Leeds was chosen as the focus of study because it has a mature commercial real estate market which has more than a century of commercial real estate development (which can therefore be compared to other secondary cities in the UK). Interestingly, Leeds is also one of the only cities in England that does not have a light rail or rapid transport (LRT) system. This means that patterns of land use and accessibility have not been influenced by LRT, which opens up the possibility of using Leeds as a reference point against which other cities with LRT may be compared.

 The objective of the paper is to start a discussion in the space syntax community concerning the human condition in urban land economic transactions and more specifically to inform how patterns of buildings and spatial connections are chosen in place. This is because it is not enough to consider how consumers receive the urban product, as urban practitioners and academics, we must also consider the characteristics and frustrations of choice. The first part of this journey is developing a method that proves the relationship between urban decision making and spatial configuration. This will then provide a foundation for a distinct area of research. Space syntax (a family of theories and methods concerning the relationship between society and space) provides us with a means of analysing this situation, in this case, in relation to commercial real estate in the city of Leeds. Previous research (Hillier and Hanson, 1984; Hillier, 1996; Penn et al., 1998) has described the inherent social logic of space and how this affects human behaviour. The rationale for these arguments is that the space syntax ‘urban spatial-network’ is a product of historical social and cultural interaction. Extending this approach and bringing to bear the burgeoning interaction between space syntax and urban economics (Chiaradia et al., 2009a; Chiaradia et al., 2009b; Narvaez et al., 2012; Desyllas, 1997; Law et al., 2013), the aim of this paper is to introduce human behaviour and its interaction with spatial configuration into the urban land transaction dialogue. In doing so, the paper investigates the hypothesis that there is a relationship between the urban spatial-network and urban decision making. In particular it seeks to probe the following question,

 Is there a relationship between urban configuration and spatial preference?

 While it may seem intuitive to suggest that environmental factors will have an impact on spatial preference, the link between physical design and urban decision making is rarely examined. Traditional research in the discipline of urban land economics (and indeed in other disciplines such as crime pattern analytics and health demographics) has historically failed to take into account the constraining nature of urban configuration (the latter two have only recently begun to incorporate configurational analysis into their fields). This is an important omission, spatial configuration may
relate to and constrain how potential building occupiers choose where to locate their business and investment activity.

By starting to ask this question, this paper links spatial configuration to cognitive decision making. In this respect this work is related but slightly removed from the recent engagement with spatial cognition (see Conroy-Dalton and Zimring (2003) for a wide ranging appraisal). This paper deals with the affect of spatial configuration upon more ‘detached’ and asynchronous spatial-decision making rather than real-time, situated, ego-centric, spatial cognitive problems, as are more typical in this field. However, the approaches are still linked as each perspective involves actively cognisant individuals or organisations in the shaping and functioning of the city. In particular, they both involve the underlying issue of how the external built environment is internalized into human behaviour. It therefore seems plausible to suggest that this potential link between urban configuration and spatial preference points toward an untapped synergy between environmental and economic psychology that could reap benefits for both disciplines.

This is potentially an important development because only focusing on property supply can lead to diagrammatic land use strategies and static methods of property designation. Of course, it almost goes without saying, that physical property has limited fungibility (the capability of mutual substitution), is illiquid, inertial and fixed in space. Presumably, the traditional maxim, location, location, location, will continue to hold sway for some time yet (Ahmed, 2011). However, occupier demand and its interaction with the urban environment is anything but: it is liquid, mobile and dynamic. Kincaid (2000, p.156) illustrates this argument with powerful sentiment,

‘By not examining the demand side of the equation we may be putting ourselves in the position of mere spectators who see the output of economic activity while having no understanding of what is necessary to the input. This is a poor position from which to make policy and a near impossible position from which to choose the particulars of the physical make-up and configuration of the built environment.’

Expounding this situation, Simon (1959), Tversky and Kahneman (1974; 1992) and Kahneman (2011) have demonstrated that ‘economic man’ can be irrational and biased and is more often than not a ‘satisfier,’ rather than ‘maximiser,’ acting in response to various external considerations. Similarly, Conroy-Dalton (2005) has demonstrated the other side of the coin, the constraining affect of the built environment on human behaviour. However, no one has linked these arguments together and the potential bias of one upon the other. By way of explanation, just as spatial configuration can affect pedestrian movement it can also potentially affect and constrain spatial preference. This demonstrates the recursive relationship between society and space. First, society creates spatial patterns of development in order to function. Second, spatial patterns help define where urban consumers choose to locate their business or build a new building for the same purpose.

However, assumptions of the real estate market which are generally based on supply and demand, whether they take the Ricardian view that land has only one use, the neo classical view that it can have alterative uses or whether it is set out in a Marxist theory of differential rent (Evans, 2004), do not account for spatial configuration. The underlying assumption is that there will be equality in goods supplied and quantity demanded, and those owners and renters of land will sell to the bidder who expects to gain the greatest income. The intrinsic principle of all three theories is that potential tenants, investors, developers and regulators have access to perfect information regarding all of the alternative properties in the market which in turn can be used to inform a bidding process. However, traditional neo-classical approaches to information ignore the costs and frustrations that customers, investors and decision makers face when choosing a location. MacLennan & O’Sullivan (2012, p.327) argue that this leads to,

‘Spatial and behavioural simplifications that allow a focus on market level, and wider, emergent price and output equilibria. Arguably these microeconomic models are not designed as frameworks for exploring real, individual behaviours, nor do they embrace temporal or spatial influences that interfere with the generation and distribution of market
Rightly, in the authors’ opinion, Maclennan and O’Sullivan (2012) argue that concentration on price and migration outcomes alone, and their construal within an equilibrium market system, does not reflect the dynamic reality of spatial commercial real estate markets.

Since Stigler’s (1961; 1962) original work into the economics of information, the role of information in markets coalesced into the information economics paradigm which examines irregularities in information and consequent distortion and mis-representation. The signalling and search behaviours of actors and agents with asymmetrical and incomplete information is now a central part of theoretical and microeconomic research (Akerlof, 1960; Spence 1973; Stiglitz & Weiss, 1981; Pissarides, 2000; Maclennan & O’Sullivan, 2012). However, the impact, and potential interference, of spatial configuration upon market signalling and screening is relatively undeveloped. This is an important omission, the innate nature of commercial real estate markets mean that satisficing consumers typically engage in search activity before agreeing to either occupy or purchase a business property. This process is undeniably spatial, therefore it stands to reason that analysing it can provide additional insight into spatial preference and guide urban policy makers and developers in providing property where potential occupiers actually need it. In addition, the preferential characteristics of spatial behaviour can also help inform the design and configuration of the built environment in ways that will be met with appreciation rather than hostility.

Addressing this issue, the method proposed in this paper combines space syntax analysis with web site search data. The intention is to reveal how market participants attempt to transact with the urban environment. Based on a one-year, search-based data set, the composite method moves beyond traditional website analysis. Instead of assessing how users interact with website platforms, it investigates how internet users utilise such resources to interact geographically with commercial retail, office and industrial property resources. The use of web analytics and its internet of space, is an explicit method of revealed preference which stands in contrast to the implicit measurement assumptions in traditional hedonic analysis. Akin to space syntax formulizations, the qualitative spatial search process, measured through website activity, leaves a geographical trace. Both approaches are an innovative epistemological solution that combines subjective data with objective methods of data analysis. They offer a complimentary cognitive geographic transaction perspective, the first dealing with spatial preference, the second the impact of urban configuration upon such inclination (indeed integration scores can be construed as preferential values themselves).

The remainder of the paper is split into three interrelated sections: The first reveals a methodology that seeks to understand the affects of spatial configuration on potential spatial preference, the second applies this methodology to the city of Leeds. The empirical findings, first of all, illustrate a method for revealing patterns of commercial real estate supply and potential occupier demand mismatch. These findings are then benchmarked against urban configuration in order to test the hypothesis that urban configuration could be a factor in this mis-match. The final section concludes that spatial configuration does have a relationship with spatial preference, contingent upon the relative type of commercial property under appraisal. It then rounds of with a summary of further opportunities for research in the complimentary realms of urban land economics and space syntax.

2. Methodological Development

Stiglitz (2002) indicates that one of the biggest problems in economics is modelling both sides of the equilibrium equation, supply and demand. We take up this challenge by framing commercial real estate occupier search behaviour (web analytics) and urban configuration (space syntax) within an experimental data set based on the National Valuation Office (VOA) summary valuation data set. The VOA data set is an accurate depiction of commercial retail, office and industrial real estate in England and Wales which is compiled every five years (and refined continually) for the purposes of business rate taxation. This data set holds building characteristics data on every commercial building in England and Wales and presents the opportunity of separation into type. For the purpose of this
paper the data set is separated into office, retail and industrial bulk class definitions which are roughly analogous with standard property use classifications used in traditional planning regulation. The proposed method is therefore composed of an accurate assessment of commercial real estate in Leeds, which is then overlaid with two additional sets of data. The first is a space syntax angular segment map which depicts spatial configuration, the second is a geographic analysis of website analytics which depicts potential spatial preference. Tentatively, this produces a proxy model of commercial real estate supply and demand which can be grounded in the built environment.

3. Rationale and Data Refinement

A spatial grid has been developed for the city of Leeds in a Geographical Information System (GIS) in order to link the respective data sets. The grid divides the city into 2.5km² grid-squares which allows for equal weighting between geographical segments, removing the bias of traditional administrative boundary allocations. The grid methodology permits matching and linking of the three data sets which would otherwise be impossible without a common unique property number (UPRN). This demonstrates the possibility for matching with additional geographic data sets (for instance demography, environment, crime/anti social behaviour, health, education, employment, business, finance and economy) to space syntax at the finest micro grain using segment line and segment proximity. The dimension for the analytical grid in Leeds has been chosen because of analytic convenience. Encouragingly, because of the underlying characteristics of the underlying information, it can be adjusted to any geographical dimension from the individual building to the entire city scale.

In order to analyse the relationship between potential urban preference and spatial configuration, several stages of data refinement and analysis needed to take place. First of all the respective bulk class property search types were mapped onto the Leeds geography (Figure 2), second, the search preference data (web analytics) were geo-located into the grid template and aggregated. This was then separated into 5 bands of preference based on search activity, and visualised using a classic heat map (Figure 3). When potential search preference is overlaid with geo located commercial real estate supply (Figure 4 and 5) it is possible to visualise patterns of mis-match in the location of physical supply and where potential occupiers actually want to locate. This is a useful tool for illustrating patterns of occupier demand and physical supply and forms a potential guide for the location of future development.

What this stage of analysis does not do is explain the underlying processes that create such patterns of mis-match. Consequently, the following space syntax exercise reveals the possibility for urban configuration analysis. It investigates one quantity of the potential underlying dynamic that causes mis-match; the potential relationship between urban configuration and potential spatial preference. This stage of enquiry combined a segment analysis of Leeds with the Leeds grid in order to analyse the affect of spatial configuration. Using the grid methodology, a proximity analysis was then conducted in order to average angular integration for each 2.5km grid square. This enabled the division of search preference scores by average integration scores in each grid square and the creation of an indicator (Figures 6, 7 and 8) that combined spatial preference with spatial configuration. The relative scoring system enabled the geographic banding and differentiation of search preference/spatial configuration density in Leeds.

This stage in analysis enabled the introduction of spatial bias into potential occupier search behaviour and can be expressed in the following conceptual model:

K Muldoon-Smith, P Greenhalgh, R Conroy-Dalton, S Alvanides, H King & B Sparks
Urban transactions: Investigating the relationship between spatial preference and spatial configuration in the city of Leeds
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4. Limitations and Opportunities for Additional Analysis

The proposed method cannot claim to represent the multi faceted nature of economic demand. Rather, it depicts one quantity of this journey, connecting spatial preference to the constraining urban environment. A significant weakness in the occupier search method is that separation between incidental and accidental versus intentional and actual transactional website visits cannot be made. Also, the data does not necessarily approximate the full market, rather it is a snap shot for two main reasons. Firstly, 2200 individual searchers were used to inform this study derived from the Leeds City Council Business Premises Search Facility (http://www.leedsandpartners.com/business/2233-2/). This is a relatively small degree of transaction activity and cannot be taken to represent the commercial property interaction in Leeds. Second, there are multiple transaction options for both buyers and sellers, not least the traditional methods of walking into an estate agent or seeing a ‘To Let’ board, neither of which is part of this data method.

Nevertheless, we contend that while the data may not be enough to describe all of the commercial real estate transaction in Leeds, it is a suitable method for demonstrating the combined potential of website analytics, GIS and space syntax. The ideal scenario would be an intelligent web resource, perhaps based on page tagging and internet protocol (IP) address. This could be specifically designed to maximise online experiences in order to drive consequent offline data capabilities. The analysis in this paper relies upon search activity and urban network density in the first instance. This is just the beginning of this method development. As towns and cities around the world continue to innovate it seems prudent to suggest that this method could be supplemented by additional information. The ‘internet of things,’ wearable devices, urban data dash boards and augmented reality all reveal the possibility of fully integrating spatial human cognition, perception and behaviour into spatial preference and choice.
5. Results and Predictions

Figure 2 illustrates the case study area, the city of Leeds in the United Kingdom, combined with a basic description of post code based search activity.

Figure 2 Search Behaviour in Leeds

Figure 3 ranks those areas that received most property search interest in 2012, into 5 bands of popularity. The info-graphic is separated into office, industrial and retail bulk class classifications, in order to articulate the different spatial characteristics of each property bulk class. The heat map shows inter market dynamics, certain areas have more popularity than others. Predictably the CBD, in relation to retail and office space, receives most interest while interest begins to dwindle toward the periphery, criss-crossed with pockets of divergence where out of town office and retail parks reside. Industrial property searches have most intensity toward the periphery, contiguous with logistical infrastructure.

Figure 3 Potential Occupier Preference in Leeds

K Muldoon-Smith, P Greenhalgh, R Conroy-Dalton, S Alvanides, H King & B Sparks
Urban transactions: Investigating the relationship between spatial preference and spatial configuration in the city of Leeds
Figures 4 and 5 merge the property search process for each bulk class on to an analysis of property supply in Leeds. The respective boxes in Figures 4 and 5 illustrate patterns of mis-match. For instance where demand is high and supply is low (and vice versa), and when both supply and demand is present. These market signals articulate the bounded interaction between occupier and property, in particular the enduring restrictions in the conditions of fixed supply and its dislocation from occupier demand. It is apparent that 'competitive' markets are not allocating resources efficiently in Leeds.

**Figure 4 Patterns of Mis-Match: Office and Retail Supply**
Why does the commercial real estate market not allocate resources efficiently? The central hypothesis in this paper proposes that one of the reasons could be relative spatial configuration. The initial proximity analysis proves that there is a relationship with potential spatial preference and urban configuration. Typically, where grid square integration is greatest, potential search preference is highest and vice versa. Yet, commercial real estate is not uniform, different bulk class typologies of property have different locational characteristics. Figure 6, indicates that the relationship between search preference for retail property and grid square integration has most density. This association is compact and almost entirely confined in and around the Leeds CBD retail box of Headrow, Vicar Lane, Boar Lane and Park Row. One explanation for this relationship is that pedestrian footfall, movement and passing trade is most closely associated with traditional retail property. Supporting this assertion the highest composite scores are in the centre of the CBD where each grid has the highest quantum of relationships with the urban whole, diminishing toward the periphery as this relationship weakens.

Figure 5 Patterns of Mis-Match: Industrial Supply
Figure 6 Spatial Preference and Angular Integration Composite Score (Retail)

Figure 7 indicates that the relationship between office property search preference and grid square integration is not as conspicuous. Consistent with conventional office market theories, the strongest scores are in prime CBD areas, however, the general pattern of scores are dispersed over a wider area than retail. Composite scores diminish towards the secondary office market areas around the periphery of the CBD. Reassuringly pockets of outlying composite scores accord with the recent development of office property on the southern side of the River Aire and the development in recent decades of office parks near the outer ring road areas.

Figure 7 Spatial Preference and Angular Integration Composite Score (Office)
One explanation for this dispersal is that this type of property is not reliant on footfall and passing trade for business activity, it is more contiguous with accessibility and proximity to transport. However, considerations of agglomeration such as proximity to workers and associated business expertise are increasingly important and may also explain this relationship. Furthermore, office property is not unrelated to retail property, it is part of a relational property market which is interconnected (quite literally in mixed use commercial buildings). For instance, many of the office workers in Leeds will form the client base for nearby retail outlets. However, it is difficult to discern a meaningful relationship between urban configuration and industrial property search preference. Figure 8 indicates that there is little relationship between industrial property and spatial integration. The CBD has high integration but low relative search preference from potential occupiers, inversely proportionate to the retail and office composite scores. This suggests that spatial integration is not a primary concern for industrial occupiers.

![Figure 8 Spatial Preference and Angular Integration Composite Score (Industrial)](image)

The reason for this is that industrial property is more likely to exist outside of areas defined by complex urban configuration, as such a spatial hierarchy is less obvious. Space hungry but traditionally low value Industrial property is more likely to exist in peripheral areas more contiguous with different types of accessibility. This type of accessibility is associated with logistical infrastructure such as roads, rail and water networks which are not picked up in this type of space syntax analysis. This conclusion is demonstrated by the high composite scores found along the banks of the River Aire and Leeds and Liverpool canal.

8. Discussion and Conclusion
The findings in this paper may seem somewhat obvious upon first reading, however, they represent the first known analysis of the relationship between where urban consumers actually want to locate and the layout of the built environment. In addition, by focusing on commercial real estate, the paper broadens the space syntax dialogue with urban economics into relative uncharted territory as it has predominately focused on residential markets. Why is this important? It is important because it suggests that spatial preference and related economic decision making isn’t just based on a set of maximising presumptions; the neo-classical invisible hand is contingent upon and potentially constrained by spatial structure. In response to the initial research question,
Is there a relationship between urban configuration and spatial preference?

The tentative findings in this paper suggest that there is, however, this relationship is not uniform. Findings suggest that it is important to separate commercial real estate into respective use classes in order to understand the variable relationship between commercial real estate and spatial configuration. The relationship between commercial real estate search preference and urban configuration is most pronounced in and around the CBD area in relation to retail use and to a certain extent, office use. Findings suggest that industrial property is not dependent on spatial integration with stock and search preference more likely to occur in lower value areas coterminous with transport infrastructure. Consequently more research will be needed to tease out the relationship between this class of commercial property stock and spatial configuration. An additional space syntax map layer incorporating specifically transport infrastructure, and processed at different radii, could supplement the method for this bulk class of property. In addition, initial findings suggest that a finer grid resolution would benefit the retail use class as this urban transaction appears most acute and takes place in a tightly bound geographical area. Finally, due to the specific nature of office use, this type of commercial property would benefit from a greater engagement with accessibility.

Due in large part to the experimental nature of this enquiry some cautionary words are necessary. The empirical findings in this paper only interrogate one half of the spatial mis-match equation, that of occupier preference, it does not probe the characteristics of supply beyond location. However, based on the findings in this paper, it is the intention that subsequent research outputs will use the grid methodology to develop a working indicator of mis-match that includes additional data layers including property stock, rental values and vacancy rates. This can then be benchmarked against space syntax in order to assess how urban configuration enables and impedes commercial real estate supply and demand. In addition, the combination of search behaviour and spatial configuration reveals the future prospect of a spatial proclivity (an inclination or predisposition toward a particular space) indicator which combines the predilection to locate, with the ability to do so.

Taking this research focus forward, we call for an open dialogue within the space syntax community in relation to human preference and decision making, its relationship with spatial configuration and the role this plays in urban land economics. To some degree the heterodox reading of urban land economics, based on cognitive (how we think) and behavioural (what we do) economics, deployed in this study is at odds with the unashamedly reductive and formal principles of space syntax. However, the initial findings in this paper indicate that the tools of space syntax also form a type of cognitive behavioural map of urban configuration that can be used to question, rather than confirm, the maximising choice presumptions of traditional urban land economics. This reveals the possibility of a fruitful dialogue between heterodox economics and space syntax in a number of areas, some of which are summarised into the following thematic areas:

- **The characteristics of real estate and urban morphology**: Is the preference for certain types of property (residential, retail, industrial, office) more susceptible/dependent on urban layout and how does this influence the formation, functioning and evolution of cities?
- **Urban adaptation and resilience**: In the future, cities are likely to be defined by their ability to adapt to new circumstances. Does the urban network influence the ability of functional land and buildings to attract new user groups and therefore their ability to adapt into new forms of use?
- **Land use and market failure**: Globalisation, economic turbulence and the changing nature of supply and demand has led to the exponential increase in vacant property and land. What can spatial configuration tell us about areas of market failure and success? Are certain locations, because of their configuration, more resilient or vulnerable to abandonment and the phenomena of urban shrinkage?
- **Urban land and property investment**: Do existing methods of property valuation and development appraisal implicitly capture/valorise spatial configuration? How does the spatial network interact with the theory of rent, and consequently the determination of commercial and economic viability?
• **Economic theory:** How can space syntax be used to compliment and challenge orthodox economic beliefs such as bid rent theory and profit maximisation? How can space syntax contribute toward alternative economic readings such as the cognitive and behavioural economic debate, information economics and the cultural-institutional perspective?

Townsend (2013) argues that urban development is going through a fundamental re-boot. We believe this provides an opportunity to enhance the current decision making methods which are available to urban professionals. Undeniably, the ability to model, share and exchange information across a whole city system is critical to better city outcomes (Leeds City Council, 2014). Indeed, findings in this paper suggest that property search participants, by their conscious interactions within the urban environment are beginning to play the role of urban programmers. This provides an opportunity to be seized in terms of integrating human behaviour into the future city dynamic. The task at hand is not easy, it will take considerable effort to understand and locate the recursive human interaction in the built environment. However, it also seems prudent to suggest that this endeavour will reveal considerable opportunities for space syntax practitioners and researchers. It seems safe to assume that understanding how people make spatial decisions (in particular where they want to locate) and indeed how such decisions are constrained by urban configuration, could be a vital component in urban master planning in the future. In conclusion, Edward Glaeser (2006) in a famous New York Times article illustrates the essence of this argument. He argued that life in a city cannot be separated from its real estate market,

'We shape cities, cities shape real estate, real estate shapes cities and cities shape us.'

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