

RESEARCH ARTICLE

The Architecture of Decision-Making Processes: A Game of Chess in the Spatial Configuration of the River Thames London

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Urban forms emerge from the interplay of social, economic, political and cultural forces, which are partly attributed to decision-making processes of urban planning and design. However, decision-making involves the everyday life of using and navigating in the built environment to the management of urban space. This paper seeks to understand the basic notion of how pedestrian movement is related to land use choices in the built form. The hypothesis is that movement itself involves a choice; that is, a decision-making of direction and destination, of passing through or of static behaviour. The density of movement flow is seen as a result of locations that potentially become attractors that have a rich distribution of land use. How we accommodate and modulate movement is thus important in helping us understand the multiple effects of everyday use that arises from decision-making processes and its subsequent effectuation in the configuration of urban space. Therefore, two key questions are addressed: first, how the types of movement choices influence and are influenced by the spatial layout; and second, how the distribution of land uses is affected by such choices. The paper uses *Space Syntax* and Game theory as a combination of theoretical frameworks that study independent and interdependent decision-making processes in urban space, to answer these questions. Taking the River Thames Path as an example, the research project focuses on the unconnected section of the river walk between London Bridge and Southwark Bridge. In analogy with a game of chess, the results demonstrate how different kinds of choices are ruled primarily by the location of commercial uses in the urban grid.

Introduction

This paper explores how choices made about land use are related to the configurational logic of space. Configurative analysis is a complex technique that explores space based on the urban grid as the fundamental generator of movement and locator of activities. The distribution of activities that people adapt and transform is produced by the choices of actions. These actions involve decision-making processes that also reflect a process of urbanity. Urbanity comes from

the notion of city form and its activity, street life and urban culture. It forms as a result of urban design, which supports and organises urban life as a 'socio-spatial category of urban form' (Marcus 2007: 3). Decision-making, in this case, refers to the outcome taken from a rational selection of alternatives that leads to a specific course of action, resulting in a final choice. Urban planning can generate strategies that serve for future urbanisation, yet the temporality of space is an important part of how different places are generated. Aldo Rossi (1982) argues that the mutations, transformations or even small alterations in a city take different lengths of

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time, but in all the cases transformations are greatly influenced by *forces* that are applied in the city. These forces may be economic, political, social or of another nature. Rossi's approach suggests the key issue is to know how such forces cause different changes in the spatial configuration of an urban area. My paper examines the forces at work on new urban design projects in the City of London that have been proposed in order to improve the pathway of the River Thames¹, mainly in the interrupted sections along the trail of the river.

One example of a project to extend the river walk was the London Promenade, which aimed to create 'a new extension to the existing promenade at the Southbank Centre, eastwards from Gabriel's Wharf, along the South Bank of the River Thames, via Bankside, Borough Market, and the Pool of London to connect with the existing jetty at Butler's Wharf (Space Syntax Ltd 2006). From a social perspective, the project's concept was based on the idea of re-connecting the river to the people by creating more accessible pedestrian and cycling routes and organising the river walk as a stage for urban performances and cultural events. From an economic perspective, the project would generate potential nodes of commercial activities that would increase local businesses and promote areas for investments.

Design proposals, like the London Promenade project, involve decision-making processes taken from architects and planning agencies. This suggests thinking about how urban configurations, land use and the socio-spatial qualities of place work together. How can we think about urban form in terms of decision-making processes and their impact in different scales of the city? In what ways does decision-making affect spatial configuration? Is this similar to the ways in which local attractors influence socio-economic activities? How do land use choices affect urban form and the social qualities of place? The strategy for answering these questions is through the principles of Game Theory, which involves studying different decision

strategies in order to explore the spatial gains or losses of those decisions. As an analogy, we can think about a game of chess. The city is a chessboard upon which different elements or 'pieces' of the game are continuously re-drawn by the 'actors', such as members of the public. The pieces that constitute the game (decision-making actors) have different rules for different 'types of movement' in order to create strategies. This means that each piece determines a type of movement that is based on a strategy made by a decision about where to go. Directional choices thus result in 'middle game' or 'end game'² situations. A middle game can be referred to as the process whereby actions are considered and developed; an end game as the definite choices selected to produce an outcome. The first step is thus to explore the layout, the underlying structure and embedded rules of the chessboard. I will follow this procedure with a description of the strategy (method), the movement of the pieces (analyses) and the possible outcomes of decisions explored in the activities in the urban realm (findings).

The Chessboard

The game board is located in the southern area of London proximate to Borough Market. The chessboard lies in between London Bridge and Southwark Bridge, an area where there is no Thames path. The area of study is referred to as *node* (**figures 1 and 2**). The reason for choosing this site is that despite the lack of continuity of the Thames Path and pedestrian access the in-between spaces of the node function as a highly commercial arena. Retail use, such as food markets and local businesses, is the main type of activity that attracts large amounts of pedestrian movement. In addition, the node is closely linked to the Southbank Centre area, one of London's major cultural areas for events, celebrations and performances. According to planning regulations the node is considered as a conservation area. These regulations would suggest that the use of land has been managed thinking also with an economic-driven development. According to the South-

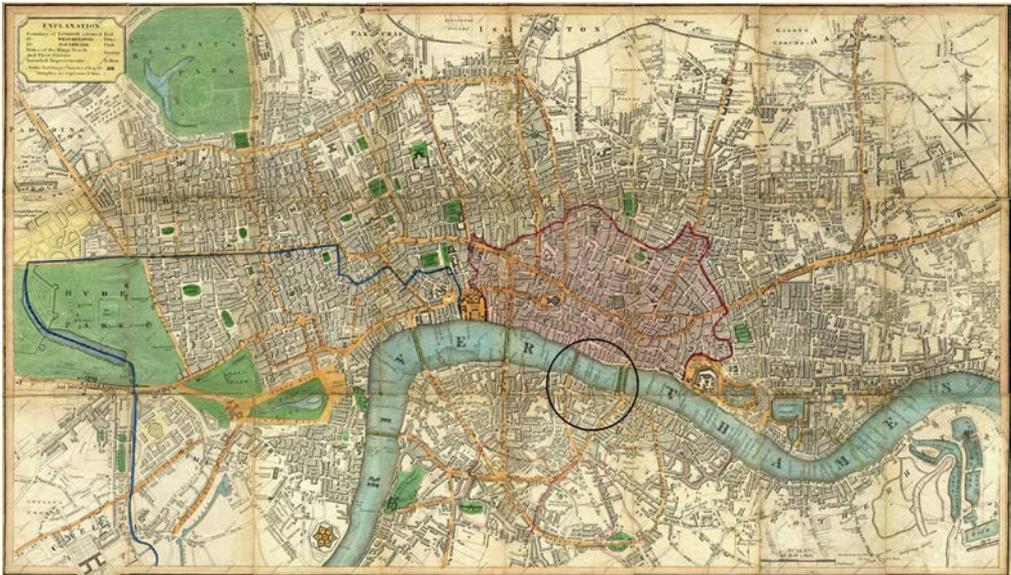


Fig. 1: Smith's New Map of London c1830 (Courtesy of MAPCO 2013).



Fig. 2: Node - Detail of case study (Courtesy of MAPCO 2013).

wark's Thames-side strategy plan (Southwark Council 2011), the policies of uses for the area include small office suites, tourist-oriented shops and the inclusion of private housing (i.e. developments of flats).

From the social and economic processes to the spatial form that the city assumes, the distribution patterns of land use has been subject to planned and unplanned urbanism. For instance, one of the crucial factors

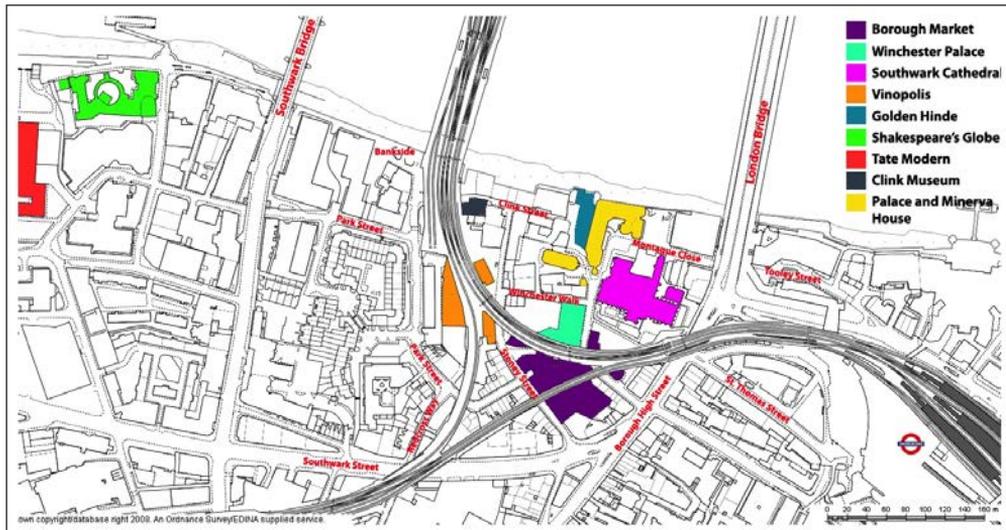


Fig. 3: Location of buildings in the area of study (by author). Map from Edina Digimap.

of decision-making that changed how people traded was the construction of London Bridge. Borough Market, a major attractor of retail activity, was initially situated on the bridge where traders sold goods, mainly vegetables in pens that usually blocked the traffic flow. According to the literature (Dean *et al* 2006; Porter 1994; Borough Market 2009), due to congestion problems the location of Borough Market moved from its original location to what is now Borough High Street. What still remains is high demand of services that has turned the market as a space for recreation and tourist attraction as well as a centre for trading goods (Borough Market 2009).

Borough Market is currently situated between Southwark Cathedral and Borough High Street along Stoney Street and is a focal point of attraction for goods and services (**figure 3**). From a spatial perspective it is difficult to suggest as to why the trustees of this particular market were not keen on changing its location. According to the Southbank Thames-side plan “the tenants have the right to move to the new Nine Elms Market [located in Lambeth] where spaces have been reserved for them, but the attitude of both tenants and trustees has been to stay put. There would seem to be little doubt that the market will

eventually become non-viable due to pressure from Nine Elms and changes in the vegetable trade” (Johnson 1969: 14). Henceforth, a socio-economic process of local trades gives a major importance to the spatial location and not only to the physical configuration of the urban area. Thus, a **spatial choice** combines a social nature that seeks quality of urban life and a spatial character defined by the urban form that results from urban design.

In its physical terms the node has a particular character. The urban grid consists mainly of narrow streets, historic buildings and regenerated areas. Aside from Borough Market, the node includes buildings that are part of the conservation zone, such as Southwark Cathedral, Winchester Palace and the Clink Prison Museum. The surroundings include several points of interest, such as Shakespeare’s Globe Theatre, the Tate Modern, the Vinopolis, the Golden Hinde and the Southbank Centre. The new developments near the Bankside, constituting mainly of private housing and offices, are the most recent urban interventions within the node’s boundaries. It is also noteworthy that, despite being a predominantly commercial area, small-gated communities can also be found near the River Thames (**figure 4**).



Fig. 4: Local areas with their own character: retail activity, private housing and transitional linkages that connect to the river walk (by author).

The Rules of the Game

The theoretical discourse is set upon the relationship between society and architecture whereby space forms an intrinsic aspect of social activity, referred to as *Space Syntax* (Hillier and Hanson 1984). *Space Syntax* takes into account measures of social relations, which are presented as representations of the spatial structure by way of linking the quantitative measures of geometrical properties of architectural and urban form (Vaughan 2007). From an urban context, Hillier's theory refers to how the natural distribution of pedestrian movement is governed by the configuration of space, namely a space of "natural movement" (Hillier *et al* 1993: 31). The theory runs that the principle agency governing movement patterns is the very configuration of space wherein retail land uses are situated in order to take advantage of the opportunities offered by the passing trade; these may well act reciprocally upon natural movement generated by

the grid configuration. Hillier describes the potential power of the spatial layout to facilitate movement and to establish the potential distribution of natural movement that a specific pathway can generate resulting in more "integrated" or "segregated" zones (Hillier 1989; 1996a). Natural movement is a key factor in understanding if land use choices are based upon where the uses are located and furthermore, how they are used and changed according to specific purposes. A further consideration is that spatial configuration exerts its effects upon movement independently of attractors, which are themselves in turn generated by multi-layered land use patterns resulting from the configuration itself. This is important since it means that attractors are not intended to look for abstract concepts typical of urban geography. In addition, Hillier expresses that the urban configuration can have an effect on two kinds of movements: "through-movement" and "to-movement" (Hillier 1989; 1996a; Hillier

and Iida 2005; Penn *et al* 1998). The first is generated from the notion that urban layout is understood as a system of routes, having a flexibility and accessibility of choices, whether they are choices of destinations or of routes. Through-movement becomes a question of the **decision of selecting a route** to get from A to B. The second kind of movement, to-movement, refers to a system of origins and destinations, constituting a **decision of where to go**. In both cases, configuration is the main generator. For example, we can consider the Borough Market area as an attractor because its location at city level functions as a through-movement area. Spatially, the market is not highly accessible within the urban grid; it is situated in between two main roads, namely Southwark Street and Borough High Street, with land uses that consist predominantly of commercial spaces.

Following this line of thought, the spatial layout that generates movement, and consequently movement influenced by land uses, creates higher flows of people. Configuration on a local urban scale generates a higher density of activities by this mixing of uses and ultimately producing land use choices. This multi-layered process is what Hillier calls “movement economy” (Hillier 1996a; 1996b). In *Space Syntax*, movement economies consist of a dynamic relationship between the patterns of spatial integration³ and the consecutive patterns of movement, which in turn shape the distribution of land uses. If the spatial configuration and movement patterns are functioning in a “balanced” way, then the different uses act as a ‘multiplying effect’ amongst each other (Kubat *et al* 2007).

In terms of urban block organisation, the size and form of the block are fundamental to the way in which uses are distributed. The arrangement of the urban block governs how street activities are performed, and thus the regulation of movement flow. The size and form of the urban block, as well as its effect on the built form, can also be dic-

tated in terms of “land parcelling, building forms, circulation patterns, and partly also land use patterns within the block” (Siskna 1997: 24). Siskna’s theory, based on North American and Australian city centres, states that layouts with smaller blocks tend to have a more fluent circulation system than larger ones. These more finely meshed pedestrian networks function particularly well in retail core blocks. In terms of lot and land use patterns, layouts with smaller blocks provide a greater length of block perimeters within the same area. The intensification of urban development in large blocks is increased by the insertion of streets and the creation of smaller blocks that ease movement circulation patterns. In the case of the Borough Market area, the major changes to the size and form of the blocks was made by the construction of the over ground railway, and the pedestrian connection to Southwark Bridge. In so doing, smaller blocks were created around Borough Market to ease pedestrian flow and connecting the northern embankment to facilitate vehicular movement.

The Strategy

The theory of games is considered as a strategy to understand how changes in the urban grid, produced by decision-making processes, have an effect on movement patterns and the built form by way of the construction of an axial map⁴ representing the street network configuration. Game theory (Von Neumann and Morgenstern 1944) is a concept used in many disciplines to study decision-making strategies; essentially, it considers who makes the first move and how it potentially affects the rest of the players⁵. Paraphrasing Binmore (1992: 23), a game is being played whenever there is a social interaction and exchange of activities within specific boundaries. ‘Game’ is thus a formal description of a strategic situation. For example, a supermarket manager decides on today’s price of meat. The manager is playing a game with his customers by offering the best price value and competing with other

rival supermarkets. Thus, game theory is a formal study of decision-making whereby two or more players are involved who make independent choices that affect the interests of other players (Turocy and Von Stengel 2001). There are many types of games⁶ (four of them are described below), which are used to explain and understand different strategic situations depending on their own backgrounds. A game can be cooperative and non-cooperative. If it is a kind of competitive game, then the outcomes can be zero or non-zero sum.

1. **Cooperative and Non-cooperative.**

The first is a *cooperative game*, which refers to a group of players able to form bindings amongst each other. "It is concerned with those situations in which players can negotiate before the game is played about what to do in the game" (Binmore 1998: 38). The game is also a competition between groups of players instead of being between individuals. The outcome is the result of a collective decision about the strategies that should be undertaken; in other words, it is a group decision-making process. The second type is called *non-cooperative* and "calls for a complete description of the rules of the game to be given so that the strategies available to the players can be studied in detail" (Binmore 1998: 21). The non-cooperative game is concerned with the analysis of strategic choices, in which the players' decisions are based upon their own interests; in the cooperative this is not the case.

2. **Zero and Non-Zero Sum.** As for strictly competitive forms of game, there are two types to consider: *zero sum* and *non-zero sum* games. The first is a game in which "the payoffs always sum to zero"⁷ (Binmore 1992: 237). Thus, one player's gain will be the other player's loss. In a non-zero sum,

there is no optimal solution like in the zero sum game. It is more like a game of Monopoly, where if one player wins the other doesn't necessarily lose. It may have equal payoffs as well. If we assume that all players can win a house from the bank, and if all players cooperate, then they all get richer and everyone wins. If one does not cooperate then this doesn't necessarily affect the payoff of the rest of the players. As Morton describes, "one decision maker's gain (or loss) does not necessarily result in the other decision makers' loss (or gain). In other words, where the winnings and losses of all players do not add up to zero and everyone can gain: a win-win game" (Morton 2007: 75).

Game Theory and Space Syntax

The proposition here is to study the possible outcomes based on geometrical parameters of the street network, at local and global scale, of the urban layout. In addition, the research project also considers observational studies of people's behaviour according to movement choices. The players are defined according to different scenarios. Firstly, the players can be the organization or group of people that are responsible for the decisions of urban policies corresponding to the area of study. This may be private investors and tenants that decide whether or not to cooperate, based on their own benefits, to change or modify any part of the local surroundings. Secondly, if pedestrian traffic generates land use choices, then the players can be also individuals that decide how to respond to the natural movement phenomena, i.e. where to go or what route to take. The question then is what kind of movement strategy do the players undertake in order to benefit from some known or unknown factor? In these terms, the people generating movement are the players. For instance, the tenants and trustees of Borough Market were reluctant to leave the area, and stayed

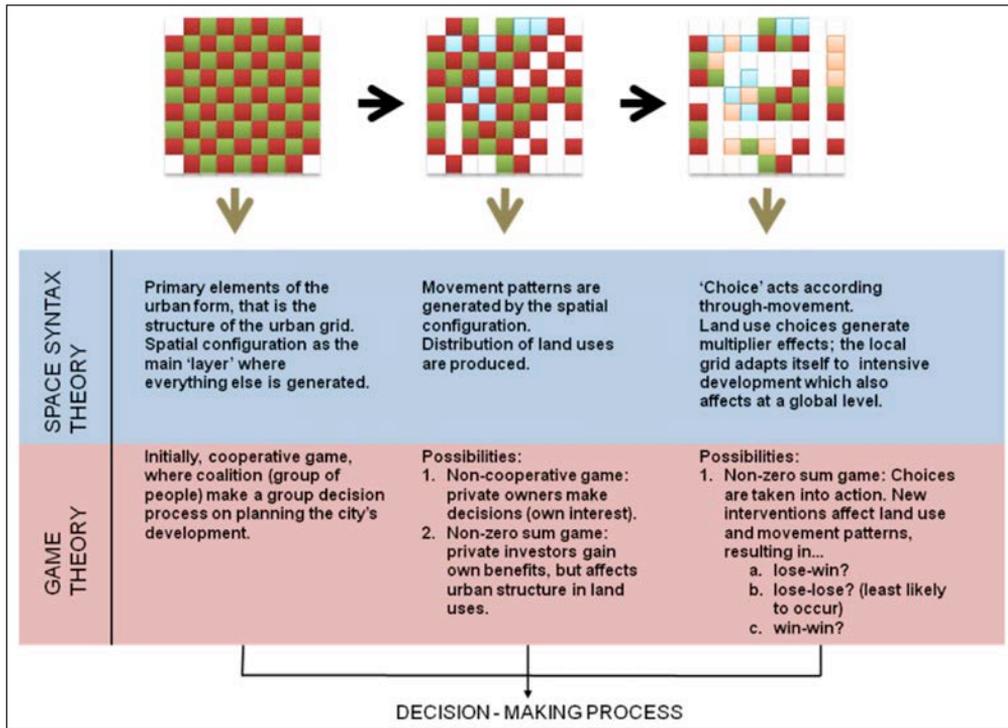


Fig. 5: Space Syntax – Game Theory theoretical framework (by author).

in the Borough of Southwark where they still reside. The questions raised are: *do I move to Nine Elms Market or not? or would it benefit or reduce the income of my business?* These questions, although hypothetical, are issues based on choices that reflect strategies of location.

The relation between *Space Syntax* and game theory is the way through which decision-making processes can be 'spatialised' and understood on different levels. Therefore, decision-making can be seen in two ways: at the macro-scale, from top-down agencies that rule and manage urban space; and at the micro-scale, from bottom-up interventions that dictate what is changed, where and how according to the needs of society. Game theory's role in *Space Syntax* theory and method is to inform the underlying choices, and thus actions, made by the different actors that determine how the physical environment will be shaped. How such diverse actions are made and what generates the movement economy, is what

the study of game theory contributes to the understanding of the social and economic qualities of urban space. This relationship is illustrated below (figure 5); the initial structure of the urban grid (chessboard) is transformed through the kind of game (cooperative) that involves a macro-scale process (i.e. planning policies). The generation of movement economies at the second stage introduces the different possibilities of production in space. Investors may act with self-interest to gain something, but the possible outcomes, far from being deterministic, appear to be the result of a non-zero sum game - an equilibrium of competing strategies that achieve a mutual gain. The outcome is the third stage of the diagram, where the choices of different actors have global effects and are principally produced from micro-scale interventions. Thus, the interventions and choices that different actors make suggest that there is a collective benefit for all participants rather than an individual gain. This again explores a bal-

ance between 'winning' and 'losing', in spatial, social and economical terms.

Who Makes the First Move?

The context within which the case study is set is based on two key issues: movement and attraction. The node can be considered as an attractor itself. As mentioned previously, *Space Syntax* theory views attraction as a property of the grid configuration – an inequality of movement. However, this carries a very different meaning in most design and planning contexts where it refers to land use characteristics. The debate between configuration and attraction involves drawing people to a focus point that deploys a movement economy process. That is to say, the development of an area as an attractor is far beyond any economic or political factors. It is a spatially-led process that is governed by three main factors: street connectivity that accounts for the distribution of pedestrian flows, the amount of land uses that emerge from the connectivity of the street network, and the density of pedestrian flow movement (Ozbil *et al* 2011).

The potential contribution of game theories in architecture and urban space is to help unpack the movement economy process by studying decision-making in a spatial fashion: movement flows as **dependent choices** taken by different actors, and patterns of use as **spatial choices**. Both types of choice are embedded and constructed as part of the architectural and urban formation of the grid. Thus, positing the chessboard as a configurative model, the 'first move' would be to distribute the pedestrian flows that are in turn guided by the different types of uses and are determined by the connectivity of the street network. This is followed by measuring the density of pedestrian movement in specific locations and the choices of direction taken from the different actors.

The methods to unfold these ideas are based on *Space Syntax* observation techniques (Vaughan 2001), which are defined as followed:

1. Segment Angular Analysis – The study area is formed as a street network into a segment map (Hillier *et al* 2007). The analysis reveals patterns of line connectivity that is called *integration*⁸, which can be the global or local measurement that extrapolates an average on all other lines within the whole configuration (Penn *et al* 1998). The study uses segment analysis, which utilises the axial map to convert each line into segments between each street (Turner 2008), measuring the segment angular integration and choice in the urban street network.⁹
2. Gate Count Method – This is a technique used to record observations of people moving in specific street locations, in and around the study area. The 'gate' is an imaginary line for each street location, which serves as a limit to count the number of people passing through that street. This helps to gather data of the amount of movement flow during different times of the day in different days of the week. Borough Market is a key area to measure the amount of movement of people during the observations. The gate counts took place on a Saturday, the busiest day of the market.
 - a. The timing is in 5-minute sets within 2 hours: 10am – 12pm / 12pm – 2pm / 2pm – 4pm / 4pm – 6pm / 6pm – 8pm.
3. Directional Splits – This method is also used for compiling observations of people, but with the difference that the observation records the split or difference of directions (in absolute numbers and percentages) of movement flows at a junction. The purpose of this technique is to find the choices of the flow of people according to the system of the node, insofar as the choice of route is generated by through-movement patterns.
4. Correlation between Gate Counts and Directional Splits Percentages –

The objective is to find how people's choices of routes are related to the number of people that pass through the corresponding gates for each directional split. These results would show an evidence of how people's choices may produce areas of more or less encounters based on how the spaces are used.

5. Land use map survey – A survey of land uses is recorded at ground and first floor levels to enhance the results of land use choice with the observation techniques and segment analyses.

Findings

1. Understanding the Chessboard

The first step is to understand what the chessboard offers; that is, **how it is used**. In the first instance, the analysis shows the consequence of movement economies shown through the distribution of patterns of land uses.

The survey shows that most of the main roads in the node consist of buildings of one to two storeys. Retail land uses are commonly found at the street level, having the Borough Market as the central point of highest retail activity.

In contrast, the existence of many vacant spaces, offered mainly as offices to let, are located primarily in large urban blocks. Dwellings consisting mostly of private hous-

ing are found near the Bankside area, from where the overground rail acts as a 'buffer' from the retail concentration of spaces near the Borough Market.

The second step is to understand the **structure of the chessboard**. This means to view the structure of the grid as a connection of streets that underpin the relational properties of spaces, namely configuration. The structure of the grid is analysed as followed:

- a. **Axial Integration Analysis** – The axial map was created within a radius of 2.5km (**figure 7a**). These first measurements show the two main arteries that function as a highly interconnected area within the whole system (global integration), which are the Southwark Bridge and the London Bridge. This recalls how selecting a destination (the node) is also determined within the context of the city. At a local level (radius 2, **figure 7b**), London Bridge remains as a richer line of connectivity and accessibility. The scatter plot (**graph 1**) shows the relation between local and global measurements where the node (highlighted in red) presents a strong correlation of synergy between the system as a whole (global) and the node (local).
- b. **Local and Global Analysis** – Segment angular integration is quantified at different radii to capture the structure of the urban grid in metric measures (**figures 8, 9, 10**). The measurements of connected areas relate to higher or lower potentials of movement within a given metric radius (i.e. at R300m is considered to represent local movement). Combining integration and choice, shown in **figure 11**, the analysis demonstrated that the urban grid functions to the highest degree on the main streets that connect the node to the rest of the city. London Bridge results as a highly used route of transportation (interconnected to the city) as well as for pedestrian transition

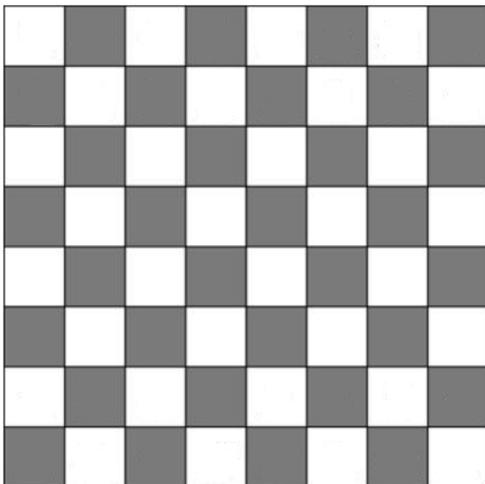




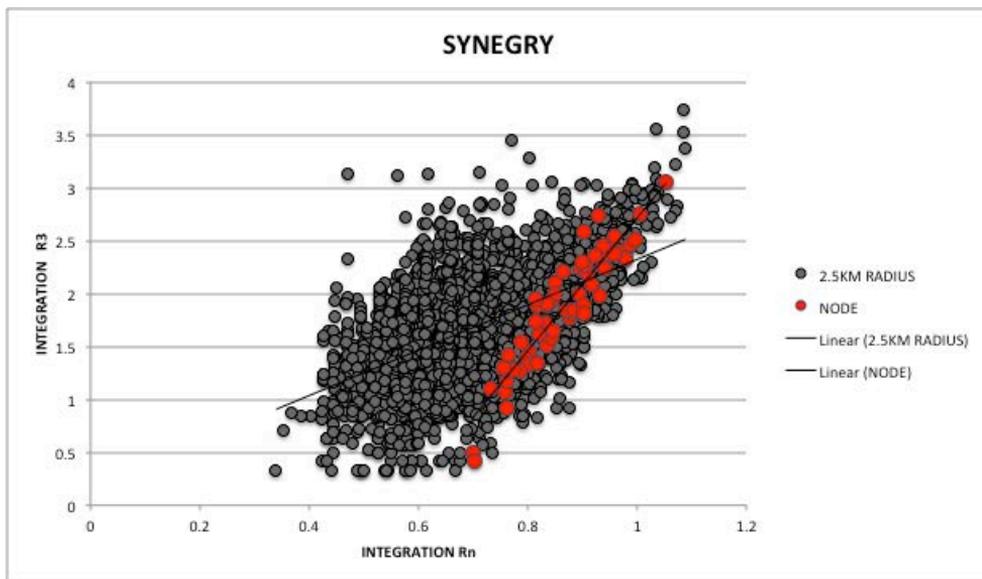
Fig. 6: Land use survey (by author): **a)** ground floor; **b)** first floor.

(local accessibility). Therefore, it is a matter of selecting a route rather than selecting a destination from an origin.

This produced the effect of making attractors like Borough Market more locally accessible.



Fig. 7: Axial Analysis at global a) and local b) radius.



Graph 1: Scatter plot of synergy: local – global integration



Fig. 8: Segment angular integration R300m.



Fig. 10: Segment angular integration R1000m.



Fig. 9: Segment angular integration R500m.

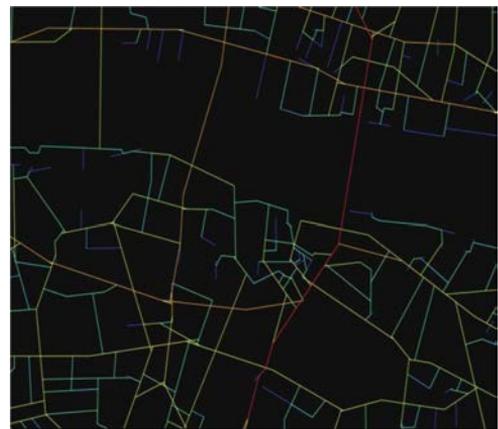
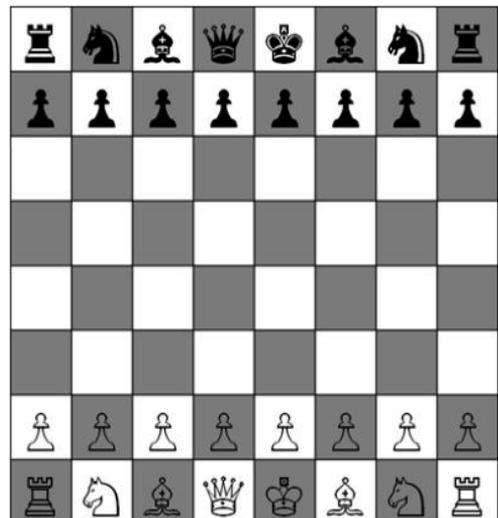
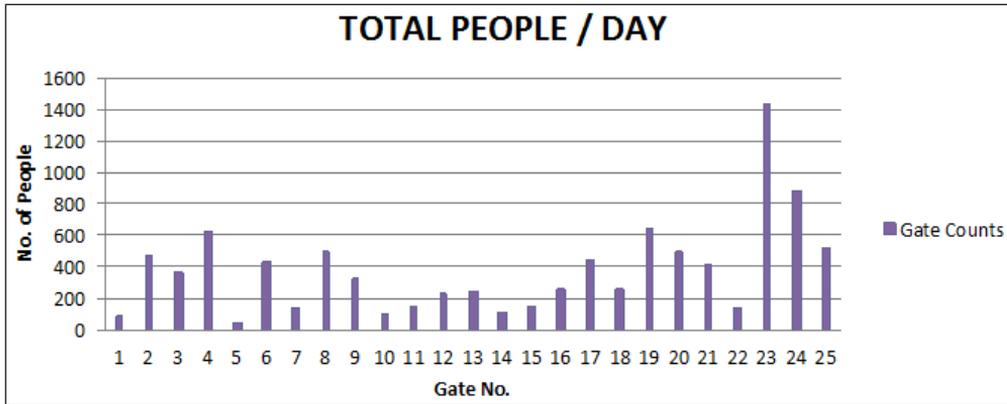


Fig. 11: Segment Angular Choice Rn.

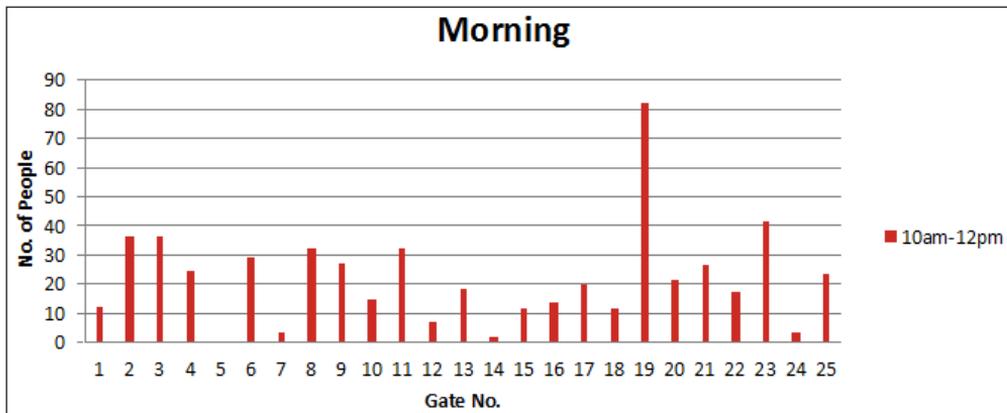
2. Understanding the Pieces of the Game

The second part of the analysis introduces a description of dependent choices resulting from the distribution of pedestrian movement flows. The following graphs demonstrate the correlation between the total number of people through each gate (**graphs 2–7**) and the percentages of each directional split. The results show that, although people tend to choose the best connected streets, there is a tendency for them to choose routes that lead to retail activities, regardless of being back streets or main roads, as **figure 12** aptly demonstrates. The mapping is further developed in **figure 13**, to extrapolate a relation to the different nodes found in the observation of directional splits.

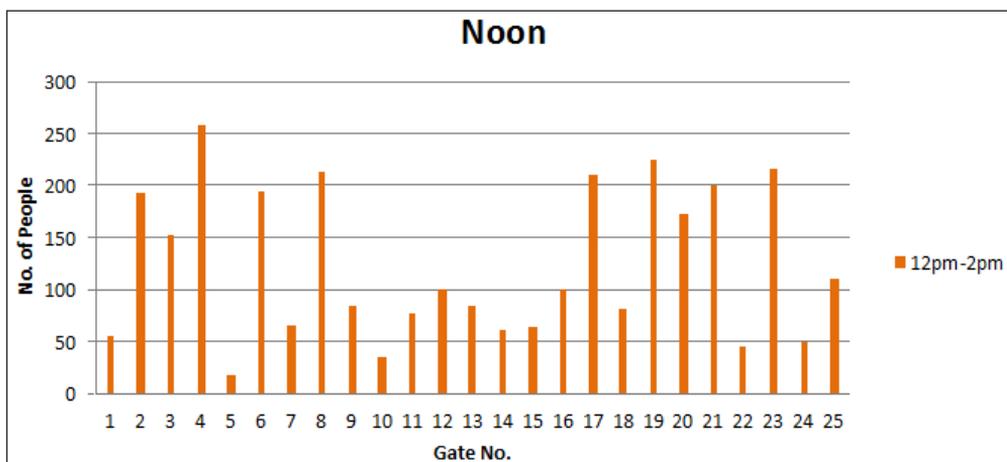




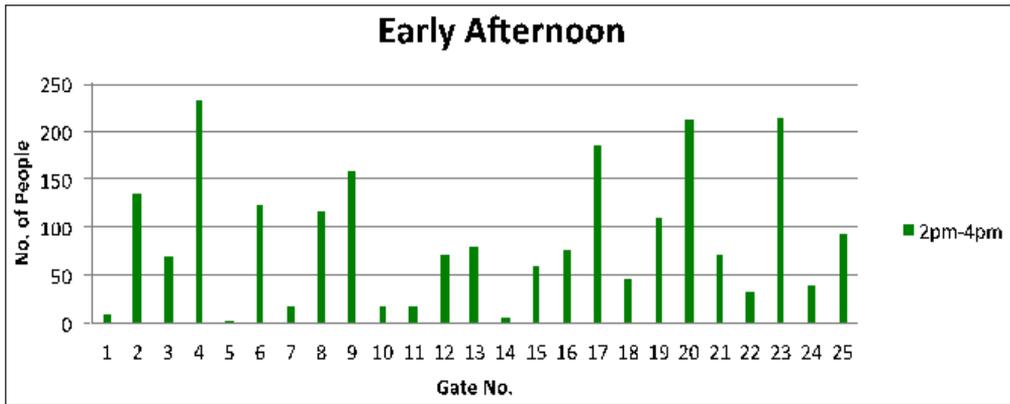
Graph 2: Total People/Day.



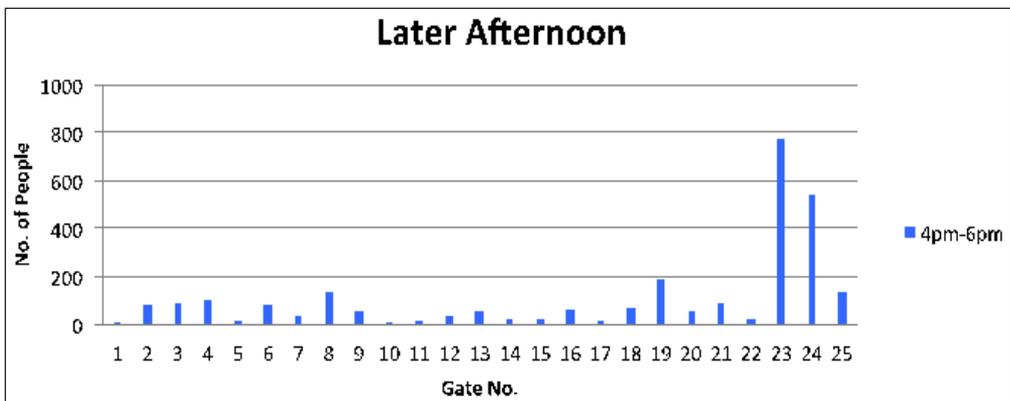
Graph 3: Total People/ Morning.



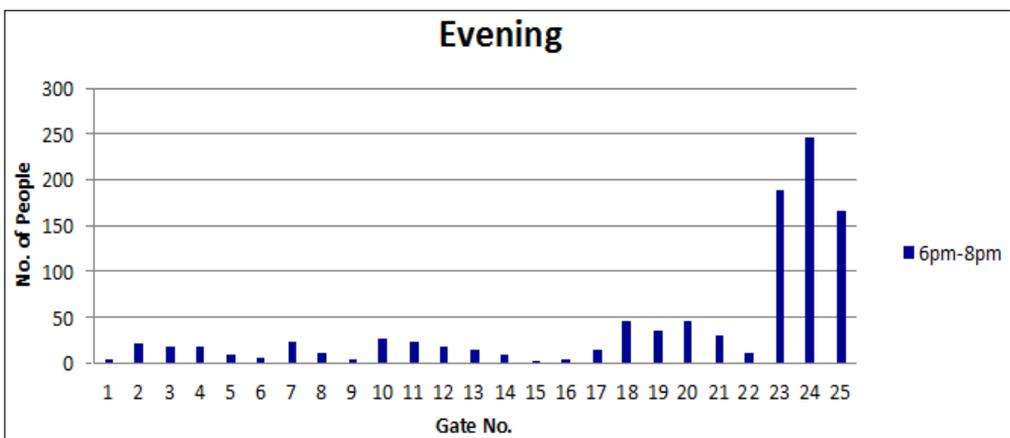
Graph 4: Total People/ Noon.



Graph 5: Total People/ Early Afternoon.



Graph 6: Total People/ Later Afternoon.



Graph 7: Total People/ Evening.



Fig. 12: Total Gate Counts during one day.

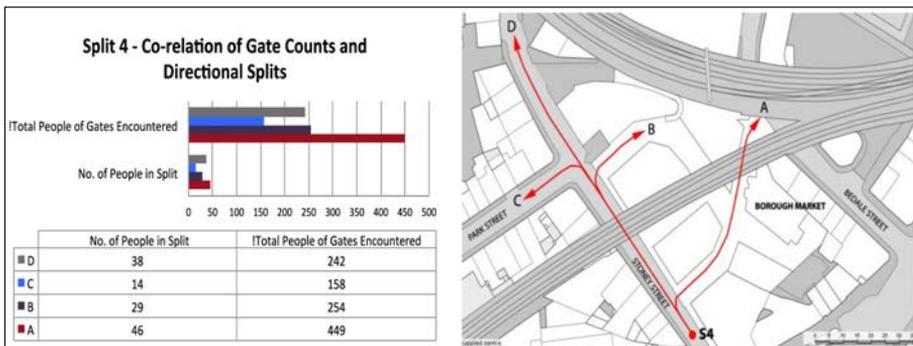
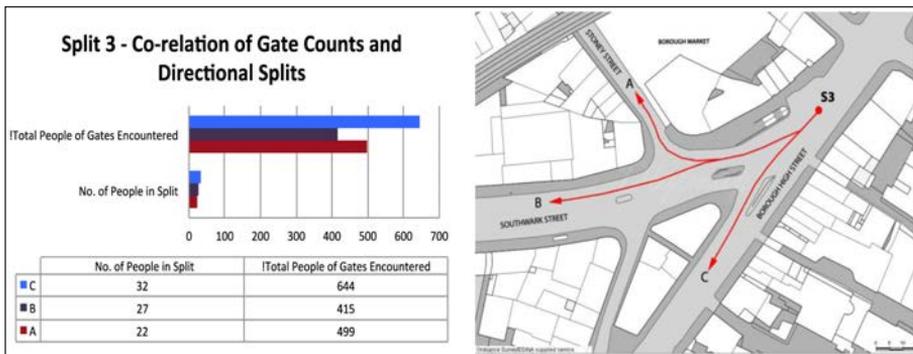
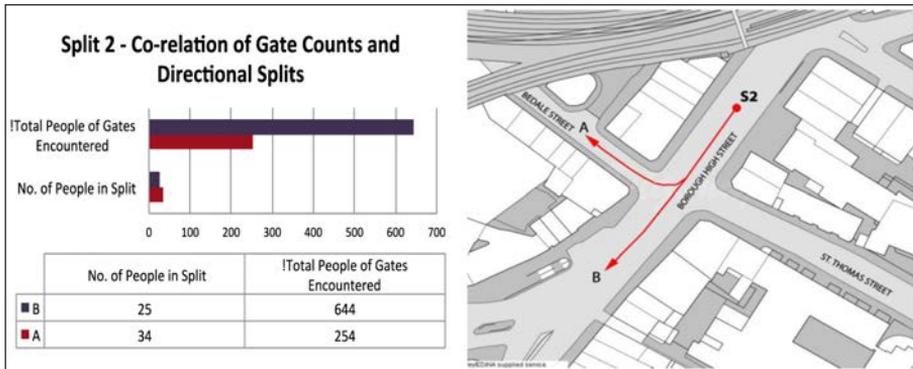
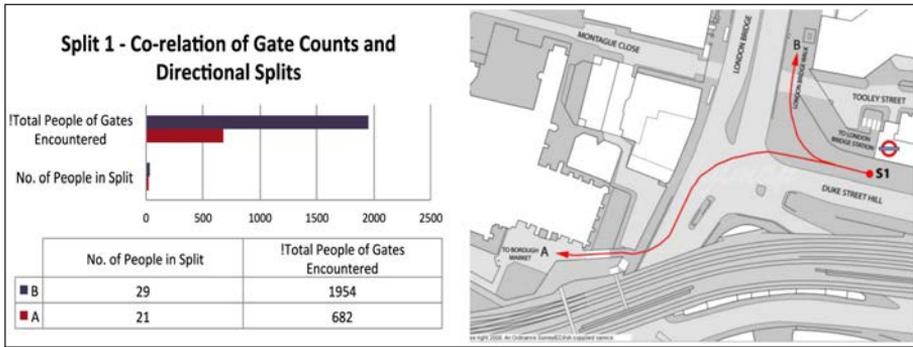


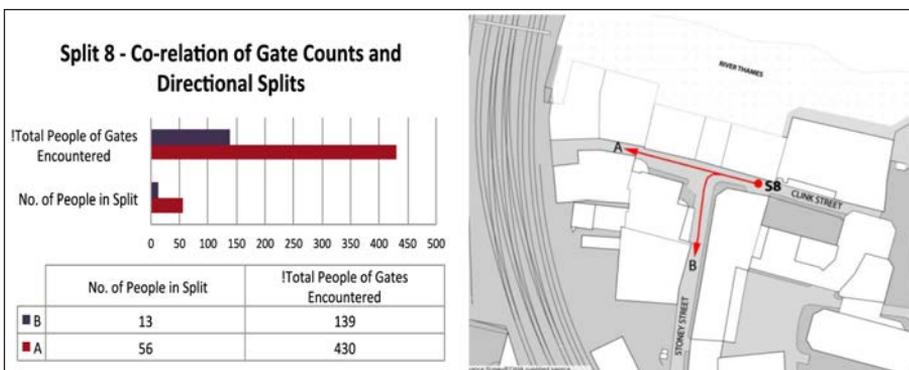
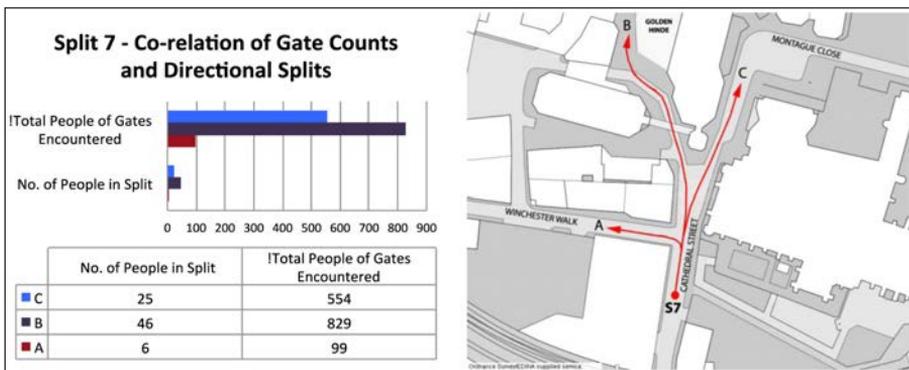
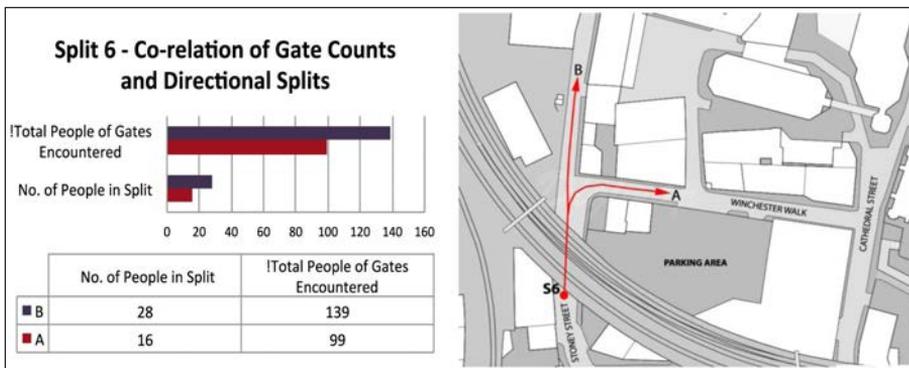
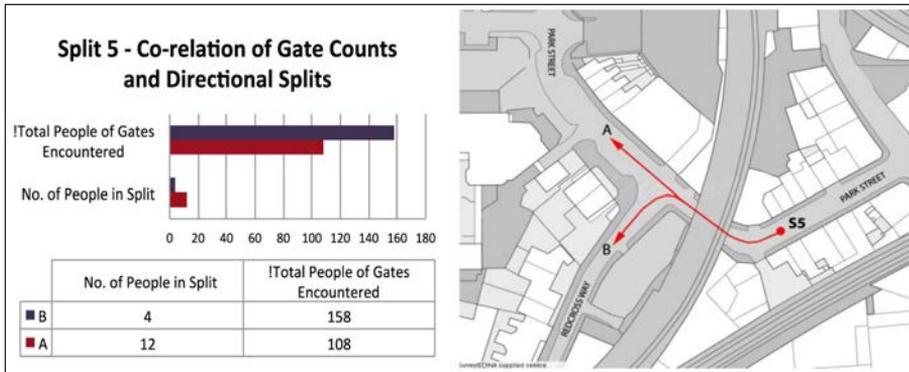
Fig. 13: Map showing the different points of Directional Splits within the area.

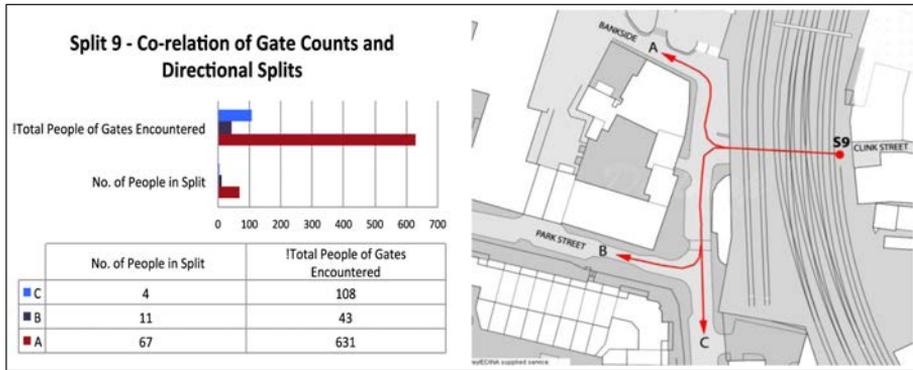
A Kind of Movement: A Knight, a Bishop and a Queen

The choices of movement are shown in the subsequent graphs, which correlate the total number of people encountered at each gate and the number of people moving in each different direction. The ‘natural’ flow of movement resembles that of various chess moves: the knight’s ‘L’ shaped turns, the bishop’s diagonal moves, and the Queen’s multiple changes of direction (split graphs 1–9). Following the chessboard analogy, the types of moves of the pieces are

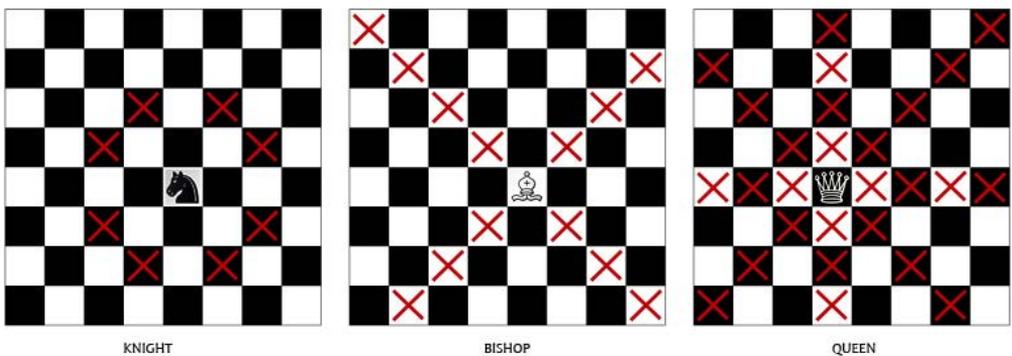
deterministic forming a logical order and sequence that is ruled by the arrangement of the black and white squares. Seemingly, in the the flow of pedestrian movement the natural tendency will follow a sequence of connected streets in the grid, making some spaces more accessible than others, some more public than others, some more commercial than residential. The underlying aspect of such logic are the choices that the decision-making actors (i.e. pedestrians) take in relation to the spatial qualities of the area.







Types of moves in chess



Re-ordering the Pieces – Three Experiments of Urban Configuration and Game Theory

Decision-making concerns possible outcomes raised by specific problems. To put the theoretical and analytical ideas into some context and show how they can elicit insights into a particular design problem, there are three examples proposed. The approach assumes three forms of ‘possible’ solutions: firstly, one that relates changing street orientation and therefore its connectivity (intervention); secondly, one that involves a continuation of the streetscape (extension); and thirdly, the addition of new streets in the urban network (creation): (1) In the first attempt an *intervention* connects the river walk to a new pedestrian route, thus increasing the probability of higher land use choices as the node becomes more integrated (**figure 14**). This means generating higher connectivity but remaining a transitional passage from the busiest streets

(i.e. main avenues) to quieter ones (i.e. local streets) (**figure 15**). Based on the directional splits observations people tend to move through the path that leads to the river walk and, in doing so, they make Borough Market an important transitional space.

(2) The second possibility is the *extension* of streets, connecting the river walk in the node with secondary streets (**figure 16**). This proposition implies that by extending local street lines the outcomes are slightly differential in terms of measures (**graph 8**), having little effect on the urban grid. Finally, (3) the third possibility involves the *creation* of streets as a ‘new river walk path’ (**figure 17**). If the creation of a new connected path is made, then this would change the movement patterns of the grid. However, the probability remains that retail uses that prevail today may have a win-win outcome. How can this be? One assumption is that if a new river walk is created, then the new path can form more commercial activity, enhancing

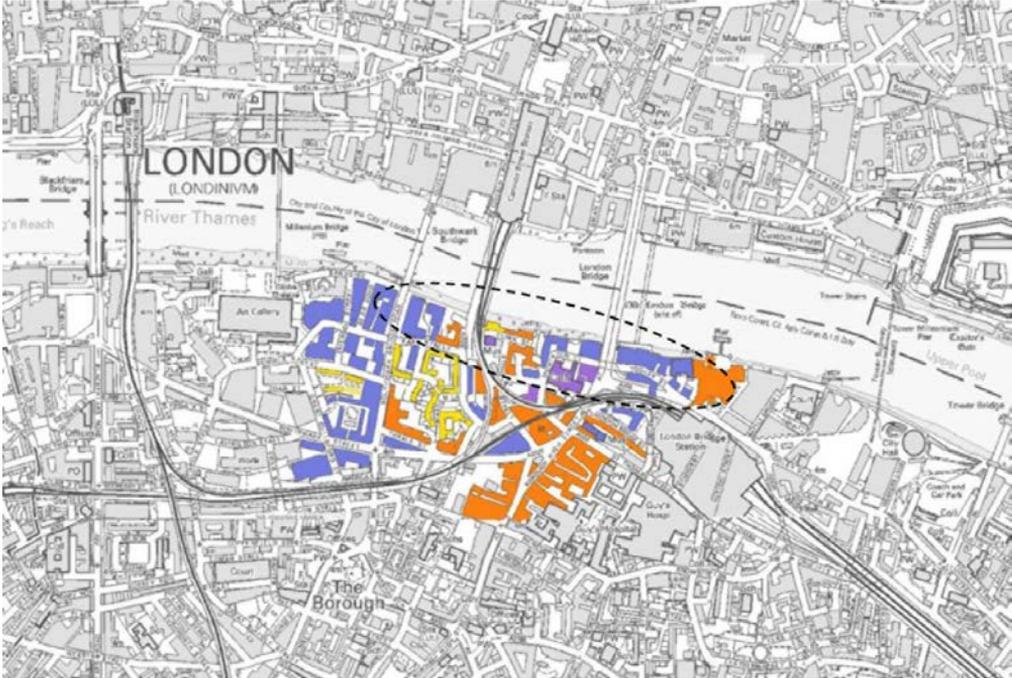


Fig. 14: Delimited area of the three experiments: river walk path in relation to the existing land uses.



Fig. 15: Experiment 1: Intervention of extending the river walk as a continuous passage.



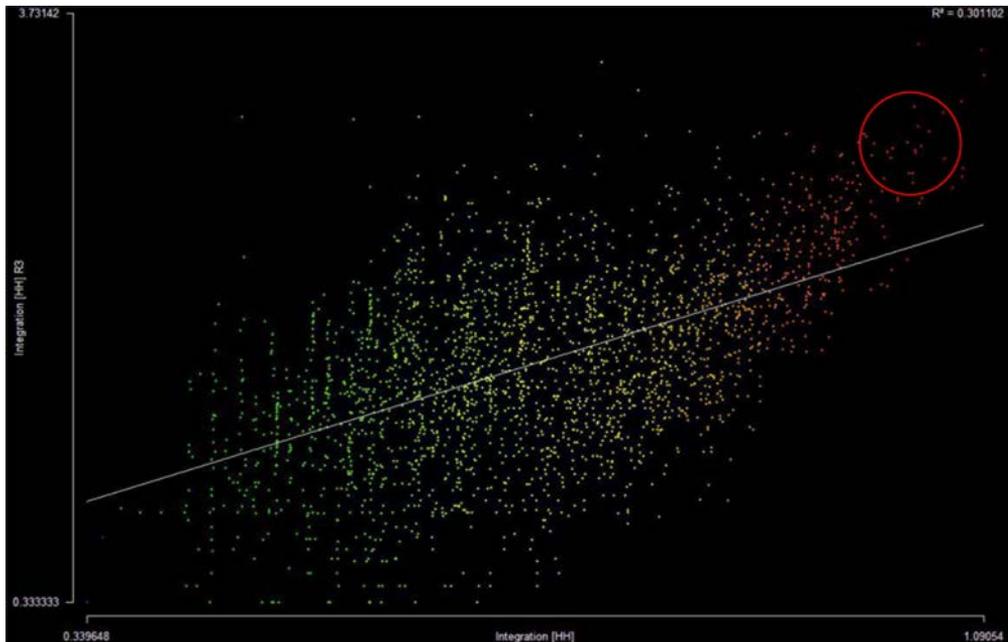
Fig. 16: Experiment 2: Extending lines directly to the new river front.



Graph 8: Scatter plot relating global and local integration with the insertion of the new path, extending the local streets.



Fig. 17: Experiment 3: By creating new lines of connection, decision-making process becomes an important factor to consider the location of land use choices.



Graph 9: A new linear pattern of retail activity is produced, and as a result a more 'central' core of economic value.

the river front as a 'passing' potential attractor leading to the Borough Market. If private investors intend to change the land use into

a commercial area, then the density of activities would increase (**graph 9**). If it results in a lose-win scenario wherein the leading

players do not cooperate with each of them remaining in their position, then the flow of people could differ remarkably. As such, movement would tend towards a more linear pattern along the new river walk, and retailers in the surrounding area would have to experiment with other strategies in order to keep their businesses running.

Checkmate – Conclusions

The land use map shows the distribution of uses are more oriented to offices, but the fact that there are several vacant spaces raises questions of how such spaces can be used as a strategic choice to bring vitality to the node. The relation of segment analyses and the observational surveys reveal that the node functions as a focus point of commercial activities that is highly locally accessible. The changes in levels of connectedness and access, imposed in the three experiments, would suggest how far the node is intelligible in relation to the functionality of the area. The notion of *intelligibility* (Penn 2011; Kim and Penn 2004), that is the degree to which that which can be seen and experienced locally in the system allows the whole urban system to be pictured and learnt from its parts, can be combined with the notion of dependent and spatial choices. Dependent choices consist more of a social nature, creating different decision-making of flows of movement. It is what people seek and experience in the urban realm. Spatial choices are of a locational nature, where different types of uses are ruled by the market trends, i.e. where to place businesses and shops ideally in the most profitable and accessible location.

In the three experiments, the extent to which the decision-making process affects these spatial properties is discussed:

1. Insertion: The implications of deciding to have the river walk in the node would affect mainly the private ownerships of the offices that connect directly to the 'new' river walk. By considering the new path itself,

the analysis showed a separation of activities in the area: those happening along the new river walk and others in the area of Borough Market. Thinking in a non-cooperative game, this is a lose-win outcome; from gaining a potential open space that is more connected at a global scale to having segregated elements in the local area.

2. Extension: The extension proposed re-connecting Stoney Street all the way to the new river walk, the exiting open pier at Montague Close, and Cathedral Street leading directly to the riverfront. Extending Stoney Street would have an effect on the size and form of the urban block, producing smaller blocks and expanding open spaces. As seen in the land use map (figures 6), there are spaces that operate as dwellings and offices, and the owners of these properties would have to decide to cooperate to this new extension of the streets. If they do not, then the outcome is likely the same as the first experiment (lose-win). If players cooperate then it can be assumed that the outcome can be a win-win situation: higher value for the properties and higher accessible services.
3. Creation: The partition of urban blocks into smaller ones also occurs as a result of adding new streets. The linearity of the grid featuring the new path has more potential, both locally and globally, for having denser movement patterns. As retail tends to develop through time in a more linear fashion (Hillier, 1999), it can be argued that there are other commercial activities functioning as attractors, such as the London Bridge Station and the 'new' river walk. In addition, this tends to create a core at a very local scale - a sub-centre within the node. The outcome of the game would be that the same players in the previous two experiments would have to analyse

their choices of how to gain more by losing less. If the only option were whether to cooperate in adapting the owner's property, then ultimately the choice resembles that of finding a new location which contains more connected areas (i.e. the newly created river path).

In all three cases, the application of the terms *winner*s and *loser*s in the decision making process would result exclusively from the degree of changes made to the existing built fabric. Changing street patterns would make a significant change on the city scale, and would also result in denser patterns of movement flows on a local level; land uses are more susceptible to experience at a local level because they are constantly changing. However, both 'winners' and 'losers' of the decision-making actions are engaged in the social qualities of place that an area offers; in socio-economic terms, the choice is about how to gain while spending less. The socio-spatial attributes of an urban area are what create a sort of 'middle game' situation. For example, the process through which social practices shape the built environment, seeking a compromise between what can be designed spatially and what is more socially beneficial.

The evidence accumulated from the data demonstrated that land use choices affect spatial configuration in a way that depends upon the decision-making of what, when, and how a new possible outcome can emerge from that decision. Decision-making processes influence the transformations of the urban structure and the way these can have an effect upon (and be affected by) the built fabric. Finally, what the analogy of the chessboard as the city tries to show is that the shape of urban space is continually redrawn by the 'players' making decisions from different movement possibilities. This potentially enables an analysis of the advantages to the urban design field of integrating theories of urban processes (the configurative analysis of *Space Syntax*) and theories of

urban design and planning (decision-making agencies).

The value of *Space Syntax* is that it allows integrating the social ideas that construct the spatial qualities of the built form into a game-theoretical perspective. The use of game theory in this research project contributed to the exploration of different urban design interventions and to highlight the types of games (zero or non-zero) and scenarios (cooperative or non-cooperative) that can result from different possible design solutions. Furthermore, game theory and *Space Syntax* can be a complementary process, such as a 'spatial-strategic' process. This means that design interventions involve local-scale decisions (centred in particular sites) and macro-scale planning (i.e. zoning policy). In both cases, the configurative structure of the urban grid is influenced by strategies taken by different players, as a bottom-up process. It is ultimately this form of process of configurative effects that this paper has attempted to address, and thus understanding the 'players' involved therein who set up the 'rules of the game'.

Notes

- ¹ This is also called 'Thames Path', which refers to the national trail that follows the length of the river Thames in Greater London. The Thames path can be walked or cycle in most of its length.
- ² In chess, the 'middle game' is the transition between opening and ending the game of chess. In general, the 'end game' occurs when just a few pieces are left. Players want the stronger pieces of the game (Queen, rooks, bishops, knights) to remain in exchange for pawns. If any pawns are left, players seek to promote these pieces by advancing them to the last rank. The movement of the King is the most important at this stage of the game.
- ³ The most important measure in *Space Syntax* for estimating the potential movement along a line is called "spatial integration" (Hillier and Hanson 1984: 96)

- ⁴ The axial map analysis means the longest and fewest lines that cover the street grid. The analysis marks measurements of patterns of line connectivity that is called 'integration', which can be the global or local measurement that gives an average on all other lines within the whole configuration (Hillier and Hanson 1984: 93–100).
- ⁵ 'Player' refers to an individual that makes decisions in a situation – a game.
- ⁶ The object of study in game theory is the game, which is a formal model of an interactive situation. It typically involves several players; a game with only one player is usually called a decision problem. The formal definition lays out the players, their preferences, their information, and the strategic actions available to them and how these influence the outcome (Turocy and Von Stengel 2001: 6).
- ⁷ A payoff is a number, also called utility, which reflects the desirability of an outcome to a player, for whatever reason. When the outcome is random, payoffs are usually weighted with their probabilities. The expected payoff incorporates the player's attitude towards risk (Turocy and Von Stengel 2001: 7–9).
- ⁸ The measurements are made at different scales of the urban system. Global integration (radius n) refers to the measure of the distance of all axial lines from one line to all others. Local integration (radius 2) refers to the measure between each line on the map and all other lines restricted to two changes of direction away from the line (see Hillier and Iida 2005; Hillier *et al*, 2007).
- ⁹ Integration measures the *to-movement* potential to a destination, that is, it refers to a system of origins, how easy is to get from one segment to the other. Choice refers to the measuring of *through-movement*, that is, the choices of routes and how accessible is to pass through a segment in a trip (Vaughan 2007).

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