HABITAT, HOUSING SOCIAL CONNECTIVITY TO PROMOTE SOCIAL WELL-BEING

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ABSTRACT

Social connectivity concepts and modelling techniques have informed built environmental design practices for centuries, even if tacitly so. Villages, cities and buildings are habitats housing social networks that configure social encounters. Questions on how the city and the building influence social and psychological behaviour and vice versa have been the focus of much theoretical discussion in recent years. Increasingly, social network analysis and space syntax analysis are used to explain how the city plan and the building plan configure social encounters. These techniques are empirical and can be used predictively for design research and development purposes. However, few have attempted to integrate these modelling techniques. The special focus of this paper is on integrating network modelling techniques to benefit built environmental design research practices concerned with habitat housing social connectivity to promote social well-being. The positive results of a test comparing space syntax calculation methods and social network analysis calculation methods are presented. A brief discussion of recent habitat regeneration initiatives in Tirana, Albania suggests the vast potential for further research integrating social network analysis concepts and modelling techniques to measure design performance.

Keywords: Building plan, network analysis, social connectivity.

1 INTRODUCTION

Social science, public health and built environmental design researchers have been concerned with social connectivity networks for many years. Yet, few attempts to integrate network modelling concepts or measurement techniques have been published. Overcoming the obstacles to integration is complicated by differences between network research and design practice concerns, concepts and terminology. For example, differences in topographic concerns and topological concerns are illuminating. Design practitioners are concerned with creating places for social encounter and site specific attributes of places – physical topographic contours and dimensions of social places, three dimensional detail including physical form and space relationships [1]. And, design code continues to be defined in terms of parameters that shape physical design outcomes [2].

In contrast, social network researchers examine structural connections or 'ties' that define a social network. Ties among the entities in a network constitute greater and lesser degrees of connectivity. An entity might be a person or an organization. A tie between entities might be an internet exchange of information. Entity details are 'attributes,' typically demographic attributes (race, income level). Social network 'boundaries' are suggested by cognitive data drawn from a group (e.g. gang membership) or a theoretical parameter (e.g. ties among 'community leaders'). Finally, ties are coded with numeric values [3].

2 HABITAT, SOCIAL CAPITAL, PUBLIC HEALTH AND GLOBALIZATION

Increasingly, built environment research and social connectivity research echo the concerns of mid-nineteenth century modernist' architects for habitat that houses social connectivity. In the 1950s Team 10 architects were concerned mainly with the ways in which the built environment can house

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physical proximity among inhabitants to promote social connectivity. They were opposed single use zoning, instead arguing for 'habitat,' characterized by 'close knit patterns of association' and 'webs' characterized by 'the repetition of similar and dissimilar' [4].

Conceptually, Team 10's concern for social connectivity addressed structural–topological issues and physical–topographical issues. Their concern was for the underlying structure of social relations as well as for the design and construction of places (topos) where social connectivity is written (graphō) into the physical contours of a particular place. Soon after, 'Hands Over the City,' Director Francesco Rosi, 1963, echoed mid-century modern architecture concerns. The film offers a poignant critique of modern housing and community development politics in Naples, Italy after World War II. Film images dramatize the destruction of historic fabric where politicians catered to developers, resulting in housing that socially and geographically isolated and marginalized and alienated people.

Today, Team 10's programme for architecture is cast in a new refreshing light by the United Nations World Health Organization (WHO) global health agenda defined as 'Generating and sustaining action across sectors to modify the behavioural, social, economic and environmental determinants of health.' This broad programme for public health encompasses the physical and mental and social well-being of populations globally [5]. WHO's programme highlights how public health issues intertwine with environmental issues and connections between the health of populations, public infrastructure, community development and neighbourhood design.

In some important ways Public Health research and practice today echo the ancient Greek art of healing, which involved 'the entire life situation of the patient, even of the physician' [6]. The Public Health profession focuses on population disease control and prevention programmes, policies, services and health systems organization. This work also involves community networks collaborating to examine 'how a community's cohesiveness affects people's health or feelings of isolation' and 'the way a population's health is affected by the physical environment' [7]. Public health research also entails environmental health impact assessment for transit projects, urban renewal plans, housing policy and sprawl [8]. Public environmental health researchers have highlighted relationships among neighbourhood layout, social connectivity and the health of special populations particularly children, the elderly and the poor. Physical isolation correlated with sprawl development, and obstacles to walking and neighbourhood social interaction have been identified as significant factors in diabetes and depression in these special populations [9].

Public Health issues intertwine with public commons resource sustainability issues, particularly 'tragedy of the commons' issues. Tragedy of the commons theory holds that self-interested overuse eventually exhausts limited 'common pool resources' (air, water, land and infrastructure) [10]. Global warming correlated with increase in greenhouse gases due to human activity is an example of the tragedy of the commons on a global scale. However, researchers have documented effective practices for sustaining common pool resources. The practices are based on the social capital derived from social networks that manage a common pool resource [11].

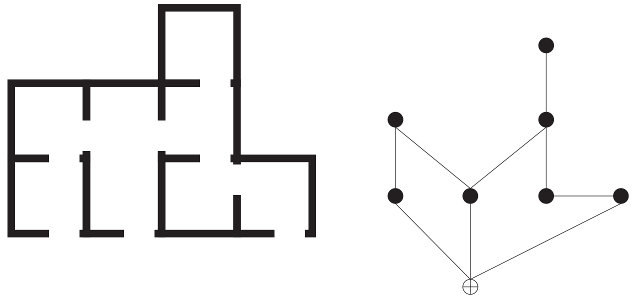
While there are different kinds of social capital and different theories about it, sociologist Michael Woolcock writes that 'the basic idea of social capital is that a person's family, friends, and associates constitute an important asset, one that can be called on in a crisis, enjoyed for its own sake, and leveraged for material gain' [12]. Fundamentally, social capital is characterized by 'social networks' and 'norms of reciprocity' associated with them [13]. Many believe social capital contributes to the organizational effectiveness and community development effectiveness of social networks [14]. Likewise, many believe 'the contours of social capital affect the health of our democracies, our communities, and ourselves' [15].

There are many well-known examples of the intertwining mutually influential relations among social capital, social networks, technology, community development and physical place. Three kinds of examples are sufficient to stake-out the topological, topographical and modelling issues of concern here: the public demonstration [16], the discipline as a field of discourse and training [17] and the research and development organization [18]. Though each example represents a different kind of phenomena, in all cases abstract social structures (topological) and concrete physical settings (topographical) and some type of social productivity are at stake. Clearly today, internet networks have become a primary mode of economic and social organization [19] where information is a commodity 'indispensable to productive power' and globalization [20]. However, the three examples identified above are also 'complex structures of discourse-practice' where 'physical objects and activities are defined and constructed.' Each 'refuses the obvious distinction between the brick and the word' [21], each is implicated in a hybrid nexus of 'relations, processes and exchanges' [22]. The intertwined relations among social capital, social networks, technology, community development and physical place present distinct challenges for modelling and measuring social connectivity in the built environment.

3 MODELLING AND MEASURING SOCIAL NETWORK CONNECTIVITY IN THE BUILT ENVIRONMENT: SPACE SYNTAX ANALYSIS AND SOCIAL NETWORK ANALYSIS

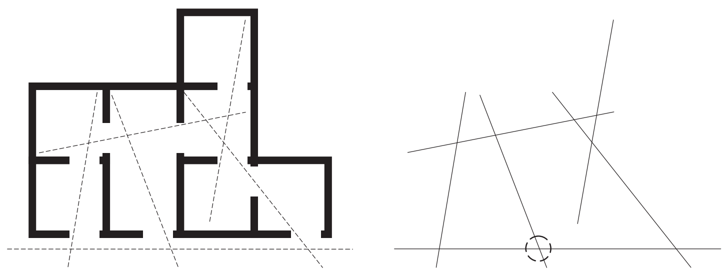
Built environmental design research using network analysis techniques extends a line of research punctuated by landmark studies in anthropology [23], organizational psychology and the social sciences [24]. Most notably, space syntax theory explains 'spatial form and the ways in which encounters are generated and controlled' from the scale of the town to the building interior [25]. Hillier and Hanson, originators of space syntax theory, developed techniques to model and measure local and global connectivity of a network of circumscribed areas in town plans and building plans. The plan network analysis techniques are used to identify topological attributes of social encounter and connectivity associated with physical layout. Further, the modelling technique enables space syntax researchers to distinguish morphological genotype–phenotype characteristics of plans that structure social encounters. The most basic distinction is between hierarchical plan networks for social encounter versus those conducive to random encounters, the latter being more probabilistic and more characteristic of modernity [26]. The topological–topographical character of the space syntax method for modelling plan networks is perhaps the most significant aspect of space syntax theory. It addresses some designerly concerns for physical configuration and research-based concerns for measurement validity and repeatability as well as transferability of the method. Though the aim here is not to fully introduce space syntax theory [27], a brief outline of the analysis technique is warranted for purposes of comparison with social network analysis techniques.

The space syntax modelling method involves the creation of graphs and axial line diagrams. In graphs, a node symbol represents a circumscribed plan area (Fig. 1). Social encounters can occur in circumscribed areas [28]. Accessibility from one area to the next is represented as a line connecting two nodes. A plan is modelled as a graph of nodes and lines. The graph represents an entire network of rooms and corridors (building plan) or streets and squares (neighbourhood plan). The graph allows one to visualize the form of the plan network, particularly the tree-like hierarchy or 'depth' of the network from a root node (typically the 'gateway' into the plan network). In this way a plan is translated (or coded) into graph form that is without scale. To measure the network represented by the graph, the number of connections linking the nodes in the system are totalled and compared with the total possible number of connections. The value for a connection between two adjacent nodes is 1 or 2 if a connection to another node passes through an intervening node, or 0 if no connection. In this way, the degree of 'integration' for an entire plan network can be measured, and the degree of integration of any particular node with the rest of the network can be measured.



Plan area: e.g. room, lobby, courtyard or public square.
⊕ Root node: gateway to plan network, e.g. corridor, street.
● Node: represents a plan area, e.g. a room, a courtyard.
— Connection: room to room access, node to node

Figure 1: Plan (left). Graph notation of plan network, (right). Key.



Plan area: e.g. room, lobby, courtyard or public square.
----- Potential straight line circulation through plan areas.
— Axial line in axial line diagram of plan.
Axial line connection.

Figure 2: Plan (left). Axial line diagram of plan network, (right). Key.

An axial line in an axial line diagram or 'axial map' represents potential circulation through circumscribed areas in a particular plan network, and connectivity among circulation paths (Fig. 2). A series of circumscribed areas in a plan that one can pass through in a straight line is represented as one axial line. Each line is a component of the entire axial line diagram network. A network of axial lines can reveal various types of plan network connectivity. For example to determine the depth of each line in the network and the degree of 'integration' of the network one can count the number of steps (line-steps) from a line to other lines in step-by-step paths leading to the outer extent of the plan network. Hence, the number of intersection-connections among the lines in the network from a root line can be totalled. The degree of integration of any particular line with the rest of the network can be measured. Any line may be chosen as a root line, but root lines are usually 'global' lines in the sense that they are a line that leads to and from the network of concern (a village, a public square, a building interior, a part of a building interior).

Thus, space syntax connectivity diagrams are initially based on physical proximity and physical accessibility but connectivity is measured as degrees of integration among nodes and axial lines that make-up a network. However, the physical distance between nodes, and the size of areas represented as nodes or axial lines, and the length and width of circulation corridors and rooms are not factors in the graph or axial line diagram. A space syntax analyst can then compare these results with observed social activity, and evidence of productivity among plan inhabitants, and perceptual data from inhabitants.

Comparison of plan network diagrams with observed social activity, productivity and perceptual data has led space syntax theory to distinguish between the physical attributes of a plan and cognitive attributes. A room may be centrally located but not actually the centre of social interaction among inhabitants of the plan, or perceived as such. Cognitively, space syntax researchers believe, a series of discrete areas bisected by an axial path (axial line) is perceived as a single movement–encounter–connectivity entity [29]. Conceptually, for modelling purposes, an axial line in an axial line diagram becomes a complex cognitive entity. An axial line diagram is mapped over the physical layout of a plan but the emphasis is on modelling and measuring cognitive units, cognitive chains of units and their levels of connectivity with the rest of the network. The topological–topographical character of network analysis enables space syntax researchers to identify, model and measure social connectivity configurations that might or might not be implied by a plan layout.

Similarly, the emphasis on cognitive attributes of a plan network has led space syntax theory to the observation that changes in path direction (changes in direction of axial line segments) as well as the number of intervening nodes along a path between any two other nodes may be better predictors of the human perception of connectivity and social encounter than physical distance. Also, visual connectivity may be a better predictor of the perception of connectivity and social encounter than number of links to and from a node. In other words, a node may be nearby but only circuitously connected or visually isolated and so more weakly connected to the social network than axial line connections might imply [30].

Planning and design researchers and practitioners mainly concerned with physical connectivity, location and distance attributes of city networks can use a multiple centrality analysis (MCA) technique to analyse plan networks, as Porta and Latora have done [31]. In MCA a city or a neighbourhood is translated as a diagram of nodes and connecting lines. Nodes designate the various kinds of entities in the urban fabric. The nodes and connecting lines make-up a network diagram. The diagram is brought into the geographic information system (GIS) to utilize the extensive GIS data base and mapping tools. Different centrality measurements and network connectivity issues can be examined: 'closeness centrality' (a nodes proximity to all other nodes), 'betweenness centrality' (extent to which a node is on shortest path between other nodes), 'straightness centrality' (measure of linearity of paths between a node and all other nodes), and many other properties of networks. These centrality concepts and analysis techniques are drawn from social network theory in the social sciences. Because social network analysis is widely recognized by researchers in various fields doing network research [32], planning and design research based on MCA lends itself to bridging with research in other fields on social networks, technological networks, information networks and biological networks.

One of the suppositions of MCA research is that compact central places that house a mixture of resources, services, entertainment and transportation options go hand-in-hand with social gathering. Conceptually, the idea of compact mixed-use neighbourhood centres aligns with public health and social well-being research concerns about the effects of sprawl on common pool resources, on the health of populations and on social capital. MCA also lends itself to integration with research into these issues by utilizing GISs data in combination with social network analysis techniques.

Like space syntax theory, MCA has topographical and topological objectives. MCA identifies structural levels of centrality among entities in a network where strength of connectivity is based on physical distance along network paths in a geographic area. Unlike space syntax theory, the focus for MCA research has been on the city and the neighbourhood, not the building plan *per se*. Also, a limitation in the MCA emphasis on physical centrality is that it does not address networks that are not implied by a city plan or geographic location.

The discussion so far brings to light an unrecognized opportunity for space syntax research. Space syntax plan integration measurement does not avail itself of the extensive concepts and techniques that are widely recognized in social network analysis research for modelling social networks. Yet, social network analysis techniques and concepts form the basis of research into technological networks, information networks, and biological networks [32]. If space syntax analysis could leverage social network analysis, it would be better positioned to bridge with research in other fields. Similarly, space syntax research would be better positioned to address other networks that are embedded in the built environment including technological networks, information networks, and biological networks. These other embedded networks form hybrid spatial networks of social encounter that influence social movement and encounter [33]. Research into these hybrids could inform the understanding of space syntax 'genotypes' [34]. Similarities in measurement aims and techniques suggest that it should not be difficult to leverage social network analysis techniques for space syntax research. Where widely recognized measures and equations 'toolboxes' can be integrated into space syntax theory without diminishing it's unique topological-topographical focus, bridging efforts across research disciplines and design practices would be better supported [35].

Differences in terminology and concepts are obstacles to bridging research efforts across disciplines. Differences in calculation method are obstacles as well. However, comparison of key terms, concepts and calculation methods suggests that space syntax analysis and social network analysis have much in common. Space syntax analysis and social network analysis use graph theoretic notation to create graphs for modelling and measuring social connectivity between entities that define a network. In social network analysis, a network graph represents a network of entities and connections among entities. In social network analysis a graph is also called a 'sociogram.' Hillier, describing space syntax analysis of building plans in *The Logic of Space*, says 'The household is a 'sociogram' of not a family but of something much more: a social system.' However, in space syntax analysis the plan network graph is called a 'depth graph,' or a 'justified graph' or simply a 'graph.' Graph notation in space syntax analysis and social network analysis uses nodes to represent entities in the network. A node in a graph is often called a 'space' in space syntax analysis. In social network analysis a node is often also called an 'actor' or perhaps a 'vertex.' Lines connecting nodes represent connections among entities. In social network analysis a line is usually referred to as a 'tie' or perhaps an 'edge.' Values can be assigned to a line to reflect the strength of a connection [36].

A main goal for space syntax analysis and for social network analysis is to measure the overall connectivity of a network. In space syntax analysis 'integration' is a key measure of the connectivity of a node with all other nodes in the network. Nodes that are better connected are better integrated. A highly integrated network in which many nodes are connected to many other nodes is called a shallow network. Relative asymmetry (RA) is a measure of the overall level of integration 'comparing how deep the system is from a particular point with how deep or shallow it theoretically could be.' RA of a node and mean RA for all nodes are 'global' measures for the network, they account for relations among all nodes in a graph to all other nodes [37]. Integration in space syntax analysis is analogous to 'closeness centrality' in social network theory where closeness centrality is also a global measure of network connectivity. These conceptual similarities in social network analysis and space syntax analysis suggest that it should be possible to leverage social network analysis techniques for space syntax research. However, space syntax uses a unique calculation method to measure network 'integration' [38]. Differences in calculation method are daunting obstacles to bridging research efforts across social network analysis and space syntax analysis.

4 TEST COMPARISON OF PLAN X AND PLAN Y: INTEGRATION AND CLOSENESS CENTRALITY

To address differences in calculation method for network integration (space syntax analysis) and closeness centrality (social network analysis) Abell, Alhusban and Alhusban analysed and compared integration and closeness centrality for Plan X and Plan Y, plans originally presented by Hillier and Penn, 1991. The plans are of research and development organization facilities in undisclosed locations. Hillier and Penn presented axial line maps for each plan, but did not create network graphs for Plan X and Plan Y or calculate network integration levels. For test comparison Abell, Alhusban and Alhusban redrew the axial line diagrams (Fig. 3) and created network graphs for Plan X and Plan Y (Figs 4 & 5) and calculated network integration and closeness centrality for both plans (Tables 1–5). The results of the Abell *et al*. analysis and comparison are summarized below.

The key issue for the test comparison is not to confirm Hillier and Penn's comments about the plans or the veracity of their axial maps; more simply the intention here is to test and compare calculation methods based on a valid theoretical construct, one that is internally consistent and logically coherent. However, like Hillier and Penn (1991), we would expect the results of the test to show that the corridors are the best connected entities because they are the spine of both plan networks. To facilitate graphic legibility and comparison, diagrams in Fig. 1, use a thick line where Hillier and Penn used a 'thick black line' to represent what Hillier and Penn call 'intercell links' where they observed that 'interactive activities concentrate' [39]. Abell *et al*. labelled line types in the Plan X and Plan Y diagrams to facilitate the comparison with Hillier and Penn 'Plan X' and 'Plan Y' diagrams. The following test comparison focuses on the global connectivity of line types. Line types are labelled and each line is numbered in the axial line diagram, ($C_1 \ldots C_n$, $I_1 \ldots I_n$, $P_1 \ldots P_n$, $F_1 \ldots F_n$).

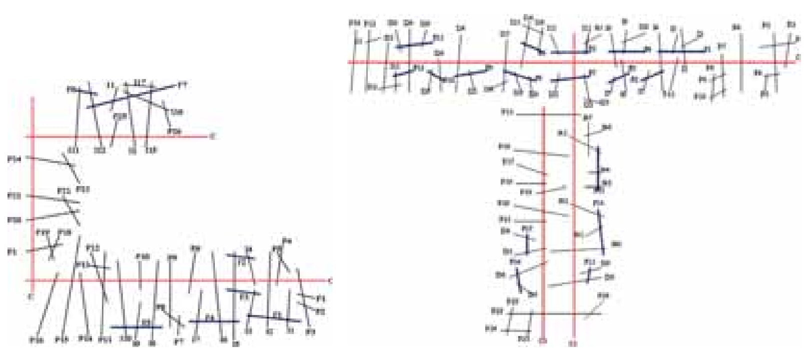


Figure 3: Axial line diagrams of Plan X (left) and Plan Y (right).

C: line representing a corridor.

F: Thick line, represents unobstructed walking and visibility path through circumscribed areas (convex polygons) where concentrations of 'interactive activities' were observed by Hillier and Penn.

I: Thin line, unobstructed walking and visibility path through circumscribed areas intersecting with thick line areas.

P: Thin line, unobstructed walking and visibility path through circumscribed areas not intersecting with thick line areas.

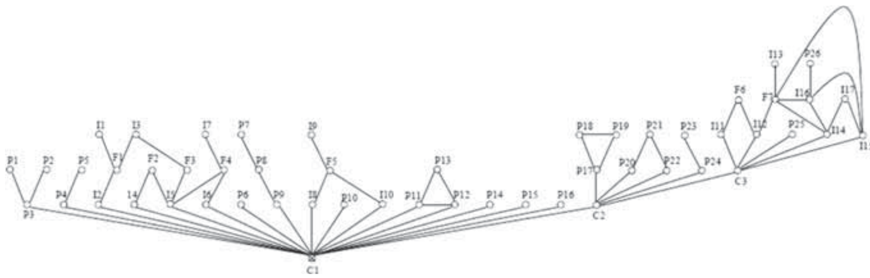


Figure 4: Graph for Plan X. Nodes represent axial lines in Fig. 1 diagram, lines connecting nodes represent intersections between designated nodes.

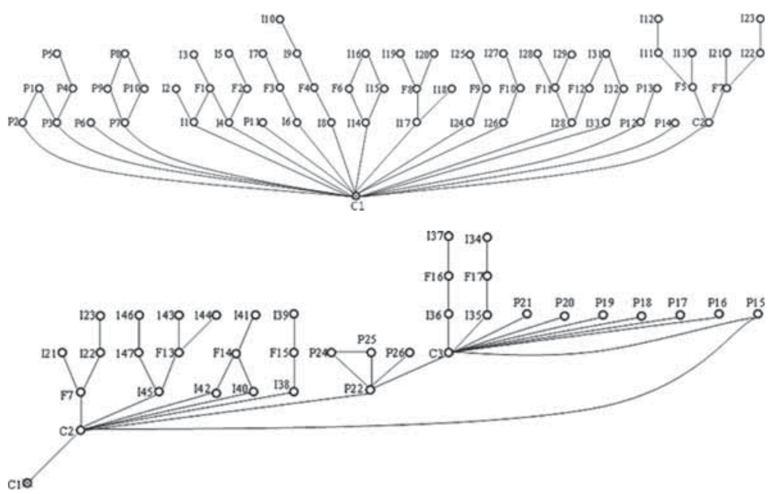


Figure 5: Graph for Plan Y above top and bottom. Nodes represent axial lines in Fig. 1 diagram, lines connecting nodes represent intersections between designated nodes.

4.1 Graph Notation

Each node is labelled and numbered according to axial lines in Plan X and Plan Y axial, shown in Fig. 1. Each line represents an intersection of two lines, in other words, the intersection of two areas of the plan represented by the lines.

4.2 Space Syntax Plan Network 'Integration' Calculation (Table 1)

1. Calculate the degree of depth (TD) for a node in the graph by counting the minimum number of intervening nodes from each node to every other node in the graph.
2. Calculate the mean degree of depth (MD). This is the mean actual depth for all nodes. Calculate by dividing the degree of depth by the number of nodes (n) less 1, shown by the equation: MD= TD/(n–1).
3. Calculate RA. This is a measure of actual connectivity compared with potential connectivity – how well connected a node is to all other nodes versus how well it could be connected given the network. (RA):RA= 2(MD–1)/(n–2).

Table 1: Space syntax plan network integration calculation results for Plan X (top) and Plan Y (bottom).

	TD	MD	RA	RAA
C1	236	2.59	0.04	0.4
C2	250	2.75	0.04	0.43
C3	370	4.07	0.07	0.76
P	395	4.34	0.07	0.83
F	416	4.57	0.08	0.89
I	437	4.81	0.08	0.95
Total				4.26

	TD	MD	RA	RAA
C1	115	2.21	0.05	0.37
C2	126	2.42	0.06	0.43
C3	156	3	0.08	0.61
P	195	3.74	0.11	0.84
I	208	4.01	0.12	0.92
F	215	4.13	0.12	0.96
Total				4.13

4. Calculate real relative asymmetry (RAA), which is used for comparing networks of very different size (different number of nodes): The actual RA of the network is compared with a 'justified' or normal distribution of nodes from the root node in the graph. RAA= RA/Dn where, Dn= s{n[log2((n+2)/3)–1]+1} / {(n–1)(n–2)}.

Table 1 is global integration values indicating the overall level of integration of the different types of entities (line types C, P, I, F) with the rest of the network. Low values indicate higher levels of integration. The tables rank the line types top to bottom, from best integrated (top) to less integrated (bottom).

4.3 Social Network Analysis Plan Network 'Closeness Centrality' Calculation (Tables 2 & 3)

1. Calculate total possible ties in the graph (L) where: G = the number of the nodes, L = G(G–1)/2
2. Calculate the mean nodal degree of the graph (D'), the mean degree of total possible network connectivity, where: D' = 2L/G
3. Calculate the density of the graph (DEN), the proportion of connections that are actually present, where: DEN = 2D'/G(G–1)
4. Calculate the degree of centrality of each node (ni), also called the nodal degree. Nodal degree indicates the number of ties that are incident with a node, a measure of connectivity of a node. As stated earlier, because Hillier and Penn identified different line types ('thick line,' thin line)

in our test comparison, we are mainly concerned with the global connectivity of line types (C, I, P, F) in the axial line diagram, and hence the connectivity of node types in the graph ($ni^{typeC, I, P, F}$). Nodal degree for line types is based on summation of nodal degree for all nodes of a particular type of node in a graph, where: $D(ni^{type})$ = {(number of very strong relationships (1)} + {(number of strong relationships) (0.80)} + {(number of moderate relationships) (0.60)} + (number of weak relationships) (0.40)} + {(number of very weak relationships)(0.20)}.

5. Calculate closeness centrality (C_c), the mean degree of connectivity of a node to other nodes in the graph. In this case calculating the mean connectivity of node types, where: $C_c = D(ni^{C, I, P, F})/G$.

The nodal degree $D(ni^{type})$ and the closeness centrality (C_c) for each node type are presented in the following tables:

Table 2: The nodal degree $D(ni^{type})$ and the closeness centrality (C_c), for each node type, Plan X (top), Plan Y (bottom).

Ni^{type}	$D(Ni^{type})$	C_c
C1	4	0.67
C2	3.8	0.63
C3	3.6	0.60
P	3	0.50
I	2.6	0.43
F	2.6	0.43

Ni^{type}	$D(Ni^{type})$	C_c
C1	3.6	0.60
C2	3.6	0.60
C3	2.6	0.43
P	2.6	0.43
F	2.2	0.36
I	1.8	0.30

Table 3: Closeness centrality (C_c), for each node type, Plan X (top), Plan Y (bottom).

Node	C1	C2	C3	P	I	F
C_c	1/0.67 1.49	1/0.63 1.58	1/0.6 1.67	1/0.50 2.00	1/0.43 2.32	1/0.43 2.32

Node	C1	C2	C3	P	F	I
C_c	1/0.60 1.67	1/0.60 1.67	1/0.43 2.32	1/0.43 2.32	1/0.36 2.77	1/0.30 3.33

4.4 Summary of Comparison

The results of the test comparison of Plan X and Plan Y indicate that differences in calculation method for network integration (space syntax analysis) and closeness centrality (social network analysis) in Plan X and Plan Y are not prohibitive obstacles for integrating social network analysis closeness centrality with space syntax analysis. While the results are provisional, they indicate that integration and closeness centrality are analogous for plan network analysis. Comparison of the global connectivity of line types (C, I, P, F) in the axial line diagram using the graph notation, closeness centrality (C_c) and integration (RAA) shows the same connectivity rankings from best to least integrated (Tables 4 & 5). As expected, the corridor values indicate that corridors are the best integrated entities in both plans. Values for the 'interactive activity' areas in Plan Y (F line type), are slightly better integrated overall than in Plan X. The values indicate that interactive activity areas Plan Y are more globally integrated than those in Plan X. Conversely, F areas in Plan X are more locally integrated at the expense of global integration. Hillier and Penn (1991) anticipated these local and global network relationships based on a visual assessment of their axial line maps and direct observation of social encounters in these areas of the plans.

Table 4: Summary Comparison, Plan X for each node type, (top) closeness centrality (C_c), (bottom) Integration (RAA), showing highest global connectivity (C1) to lowest (F).

Node	C1	C2	C3	P	I	F
C_c	1/0.67 1.49	1/0.63 1.58	1/0.6 1.67	1/0.50 2.00	1/0.43 2.32	1/0.43 2.32

Node	C1	C2	C3	P	I	F
RAA	0.37	0.43	0.61	0.84	0.92	0.96

Table 5: Summary Comparison, Plan Y for each node type, (top) closeness centrality (C_c), (bottom) Integration (RAA), showing highest global connectivity (C1) to lowest (F).

Node	C1	C2	C3	P	F	I
C_c	1/0.60 1.67	1/0.60 1.67	1/0.43 2.32	1/0.43 2.32	1/0.36 2.77	1/0.30 3.33

Node	C1	C2	C3	P	F	I
RAA	0.40	0.43	0.76	0.83	0.89	0.95

The results of the test comparison offer an empirical basis for integrating social network analysis closeness centrality with space syntax analysis without diminishing the unique topological–topographical focus of space syntax analysis. It should be possible for others to integrate the closeness centrality concept and calculation into space syntax network analysis.

More speculatively, the results suggest that space syntax researchers could avail themselves of the extensive concepts and techniques for modelling social networks without diminishing the unique topological–topographical focus of space syntax analysis. Space syntax researchers could perhaps then also address technological networks, information networks and biological networks in cities and buildings that constitute hybrid space of encounter 'genotypes.'

On a less theoretical level, the results have implications for community development and performance-based design research and development practices concerned with habitat housing social connectivity. For example, habitat regeneration initiatives like those in Tirana, Albania suggest the vast potential for further research integrating social network analysis concepts and modelling techniques to measure and predict design performance. The urban context of Tirana, the capitol of Albania, is a highly suggestive case for incorporating social network theory concepts and analysis with space syntax research to benefit habitat housing social connectivity. Since 1991, Tirana has been transitioning from an authoritarian political system to one emphasizing community development efforts to generate social-democratic habitat based partly on regenerative planning and design initiatives.

Transition conditions in Tirana have been distinguished by rapid geographic expansion, rapid migration into the city, initiatives to access the global market place, as well as growth of urban infrastructure, social services and housing for traditional and non-traditional working families migrating to the city. Edi Rama, Prime Minister-designate of Albania, a former Mayor of Tirana and modern artist, advocates a programme of socio-democratic community development initiatives for Tirana and the nation. Rama's urban habitat regeneration initiatives have included rejuvenation of streets and squares, painting communist-era housing blocks in colourful and experimental styles, and holding international planning and design competitions resulting in competition-winning proposals for the city of Tirana [40].

While there are no readily available well-documented examples of buildings that have been built or proposed for Tirana's regeneration, some completed initiatives for streets and squares are now observable *in situ*. The Franz Joseph Strauss Plaza in Tirana, redesigned in 2009 is an example of community development efforts led by Rama while Mayor of Tirana. The rectangular plaza is at the confluence of intersecting pedestrian and vehicular transit paths. The communist-era housing slabs that circumscribe the plaza are each characterized by contrasting paint colours delineating abstract patterns. A rectangular platform raised three steps up from the street level has been introduced across

Figure 6: The Franz Joseph Strauss Plaza, Tirana, Albania.

the entire former plaza. The platform is distinguished by a grove of trees spaced evenly on a grid pattern. Each tree is surrounded by a bench. Social activity in the plaza itself appears to be robust. Varying intensities of social activity across the redesigned plaza are now common. Shops, cafe, and a variety of small businesses surround the plaza at street level. People relax and socialize in the plaza, playing dominoes, backgammon or chess, and chat.

The Franz Joseph Strauss Plaza and other regeneration initiatives in Tirana and elsewhere could be the focus of space syntax research leveraging social network analysis. Research could focus on the evaluation of regeneration initiatives to better understand how to strategically support the development of habitat housing social connectivity and social well-being. More specifically, research could focus on how to tactically inhabit the existing urban fabric to configure local–global network relations to provide neighbourhood services and infrastructure as well as to promote social capital development. Integrating widely recognized social network analysis concepts and measurement techniques particularly closeness centrality with space syntax analysis would benefit such research.

5 CONCLUSION

Cities and buildings are habitats housing social networks that configure social encounters. Increasingly, social network analysis and space syntax analysis are used to explain how the city plan and the building plan configure social encounters. These techniques are empirical and can be used predictively for design research and development purposes. However, few have attempted to integrate these modelling techniques. Three kinds of examples were identified to stake-out the mixture of topological, topographical and modelling issues of concern in this paper: the public demonstration, the discipline as a field of discourse and training, and the research and development organization. Though each example represents a different kind of phenomena, in all cases abstract social structures (topological) and concrete physical settings (topographical) and some type of social productivity are at stake. The special focus of this paper has been on integrating network modelling techniques to benefit built environmental design research practices concerned with habitat housing social connectivity to promote social well-being. The positive results of a test comparing space syntax calculation methods and social network analysis calculation methods were presented. The results suggest that space syntax researchers could avail themselves of the extensive concepts and techniques for modelling social networks without diminishing the unique topological–topographical focus of space syntax analysis. Space syntax researchers could perhaps then also address technological networks, information networks, and biological networks in cities and buildings that constitute hybrid space of encounter ‘genotypes.’ Habitat regeneration initiatives like those in Tirana, Albania suggest the vast potential for further research integrating social network analysis concepts and modelling techniques to measure and predict design performance.

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[28] Space syntax also involves converting (coding) a plan into circumscribed areas called 'convex polygons,' and then into 'axial lines' diagrams to account for the cellular attributes of the various areas (rooms and corridors, streets and squares, or implied rooms etc.) that make-up a plan network. In all cases however, the goal is to measure the overall level of integration of the entities (nodes, circumscribed 'convex polygon' areas, or axial lines) based on the connectivity of the entities in the overall network system in question. In other words, the goal is to measure the level of integration of the 'global structure' of the network. Hillier, B. & Hanson, J., *The Social Logic of Space*, Cambridge University Press: Cambridge, p. 108, 1984. Banfa writes "integration represents the average depth of the spatial unit from all other spatial units within a given system, and hence its value is affected by the entire spatial configuration. Banfa, S., Space syntax: a brief introduction to its logic and analytical techniques. *Environment and Behavior*, **35(17)**, pp. 17–29, p. 27, 2003.

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