

VIRTUAL COMMUNITIES AND PATTERNS OF SOCIAL INTERACTIONS IN 'TECH CITY'

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ABSTRACT

The impact of social media and Web 2.0 on socioeconomic behaviour in the physical space of the built environment had recently become a matter of intense debate in social sciences and human geography. This paper examines the relationship between the configurations of urban space from the perspective of 'space syntax' theory by Hillier and Hanson (1984) and the configurations of social networks in Twitter, whilst focusing on the technology start-up cluster in 'Tech City' London. Where there has been arguments made for a strong correlation between twitter ties in businesses and physical distance, this research is focused on the borough scale aiming to outline a relationship between the configurations of streets and the virtual and socioeconomic attributes of start-up businesses. The paper reports a moderate relationship between indices of centrality in twitter network

and its correspondent measure in street networks. In addition, the research yields global and temporal patterns of relationships with land uses and land values. The paper concludes by reflecting on how the configurations of twitter Tech-City community are present in the physical medium, where short and long links define the local and global part-whole relationship between Tech-City and other communities.

1. INTRODUCTION

The impact of social media and Web 2.0 on socioeconomic behaviour in the physical space of the built environment had recently become a matter of intense debate in social sciences and human geography. This paper examines the relationship between the configurations of urban space from the perspective of 'space syntax' theory by Hillier and Hanson (1984) and the configurations of social networks in Twitter, whilst focusing on the technology start-up cluster in 'Tech City' London. Where there has been arguments made for a strong correlation between twitter ties in businesses and physical distance, this research is focused on the borough scale aiming to outline a relationship between the configurations of streets and the virtual and socioeconomic attributes of start-up businesses. The paper reports a moderate relationship between indices of centrality in twitter network and its correspondent measure in street networks. In addition, the research yields global and temporal patterns of relationships with land uses and land values. The paper concludes by reflecting on how the configurations of twitter Tech-City community are present in the physical medium, where short and long links define the local and global part-whole relationship between Tech-City and other communities.

2. LITERATURE REVIEW

2.1 Twitter as a Social Networking Service

Since 2007, Twitter and Facebook have been the most successful social networks, in the UK it was estimated that the total number of users was 15 million for Twitter in September 2013, and 31 million for Facebook in December 2013¹.

Twitter is a social networking utility that limits posts to 140 characters for each message. An example on a Tweet user interface is displayed in Figure 1. Tweets may contain a mention, which links the tweet to a specific user, and a hashtag, which links tweets to specific pages with the same hashtag title. In Twitter, users can follow each other's pages. It is characterized by its wide accessibility through different means (see Figure 2).



Figure 1- A typical tweet in Twitter: 1. Hashtag 2. Mention 5. Link (WTWH Marketing Lab, 2012)

¹ Source: www.rosemcgrory.co.uk [last accessed August 2014]

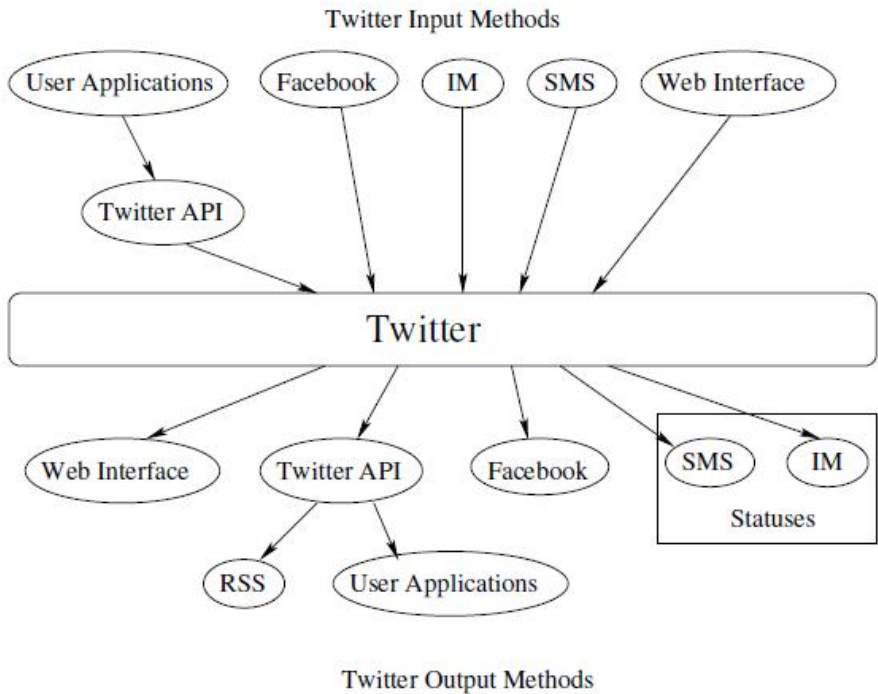


Figure 2 - Twitter Input and Output Methods Arlitt et al. (2008)

2.2 Interactions in Physical and Virtual Spaces

Researchers, including Atkinson (1998) and Morgan (2001), have seen what can be called 'the death of space' or 'the death of geography', as termed by Cairncross (2001), which points to the death of space with the advent of social technology. Cyberspace had been theorized, predominantly, as a 'space of flows' (Castells, 1996) and as in (Urry, 2007), part of a mobilities paradigm.

According to Castells (1996), the new millennium is articulated as an age of 'globalisation', wherein technology breaks the geographic boundaries and isolation of the developing countries. Castells (1996) introduced the term 'space of flows', where social practices dominate and shape a networked society. The space of flows can be categorized into three layers: the first contains a network of electronic exchanges; the second is made of nodes and hubs; and the third refers to the spatial organization of the dominant managerial elites (who direct the functions of the virtual space).

Urry (2007) introduced the mobility paradigm in an attempt to conceptualize 'movement-driven social science' (Urry, 2007: 18), focusing on the movement of people, objects, information and ideas of contemporary society. Urry's research introduced five mobility² paradigms, each constituting circulating entities between spaces, these paradigms were centred on moving entities and their effects in society. He has projected the value of places on their meaning and their affordances, but has not shown any awareness of the presence of street networks and the differences between neighbourhood configurations.

Castells' (1996) account of space is based on the concept that ancient societies were limited in their interactions to their own geographic zones, and had attempted to justify this conception through discussion of the gap in the development of technologies between China and the West. This is debatable, as there have been interactions between different cultures in the past; this misconception was referred to by Hillier and Netto (2002) as the 'myth of historical

² *These paradigms are: corporeal travel of people, physical movement of objects, imaginative travel, communicative travel, and virtual travel*

spatiality'. Moreover, it was suggested by Urry (2002: 16) that 'there are wide possibilities of virtual proximities simulating physical presence, especially with regards to proximities around objects and events'.

In the search for a theoretical overlap between social theories of physical and virtual space, Weissenborn's (2010) thesis had built on the body of work in Bill Hillier's space syntax theory (Hillier and Hanson, 1984; Hillier, 1996) through extracting concepts that could be integrated in a framework to be compared to the work on virtual space and society of Yochai Benkler (2002, 2006). Weissenborn (2010) found common ground between the two forms of space in 'morphic languages'³; specifically the notion of logical space⁴ (Weissenborn, 2010: 55). However, in the virtual space morphic language corresponds to 'feasibility spaces' (Benkler, 2006), which through change unfold socio-cultural production, organization and communications, thereby creating a 'networked information environment' (Weissenborn, 2010: 55).

2.3 Studies on Virtual Activity and Physical Presence in Societies

Social network sites are good sources for collecting data about networks' and users' behaviours. In one of the early analyses of the structure of followers and followees in Twitter (Huberman et al., 2008) which includes a sample of 309,740 users, it was shown that the number of followers or followees (see Figure 3) does not always

³ *Morphic language in space syntax (Hillier and Hanson, 1984: 48) is defined as 'any set of entities that are ordered into different arrangements by a syntax as to constitute social knowables'*

⁴ *Logical space can be defined as 'a discontinuous world of expressive forms, signs and symbols which we occupy cognitively' (Hillier, 1996: 305).*

indicate the number of friends; however, the number of posts increases directly with the number of close users (see Figure 4).

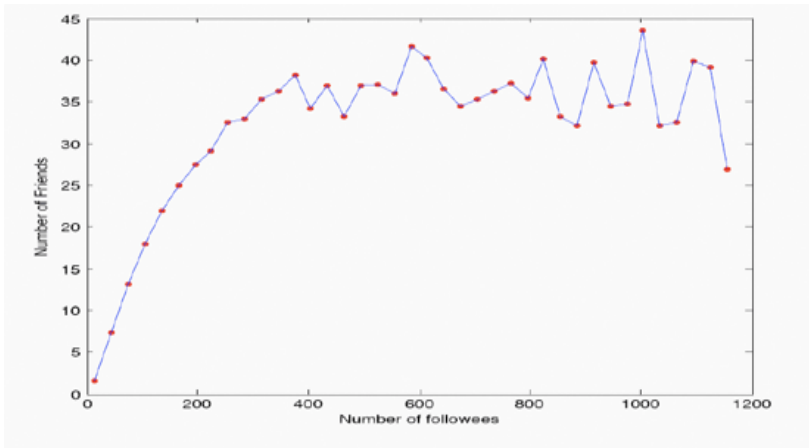


Figure 3 - Number of Friends against Number of followees (Huberman et al., 2008)

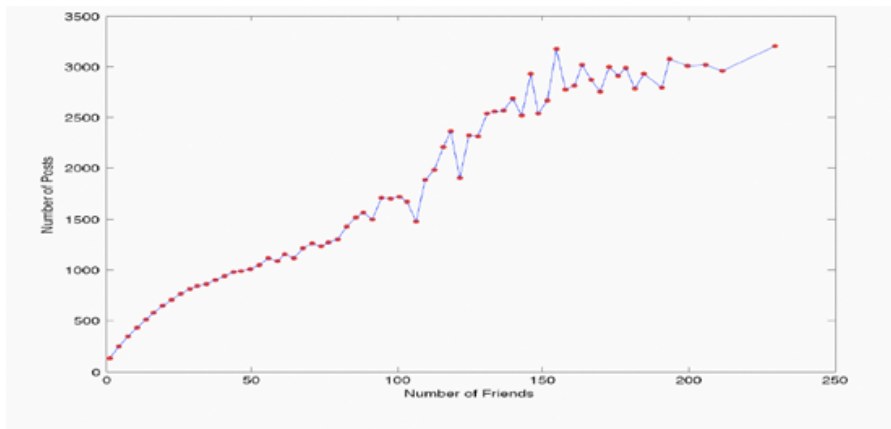


Figure 4 - Number of Posts against Number of Friends (Huberman et al., 2008)

There have been several studies examining user activities in the online and the offline life. One of the most prominent of these, (Cranshaw et al., 2010) compared the social setting of spaces, users' physical movement and their Twitter activities. It was found that the users' visit locations and regularity are better predictors of their social ties, i.e. their online friends. Based on a measure called entropy⁵ as the main variable, it was found that if the users were observed with others in high entropy area (places with a high probability of encounters) those they encountered were less likely to be their friends in the social networks. In another experiment (Garcia-Gavilanes, Mejova and Quercia, 2014), it was shown that the business connections between different world cities in Twitter were biased by the inverse relation with geographical distance, with a correlation of $r = 0.68$.

In summary, there are several strands of research characterizing Twitter's user activity, explaining the variables (physical distance, language and coexistence) that influence the structure and intensity of social ties. Yet, to the authors' knowledge, there has been little research on social networks at street or district level taking into account urban space configuration and Twitter structure activity. Most recent research has been focused on taking relatively large clusters, which could possibly be explained by the popularity, density and the frequency of interest in online social network sites in the research areas.

⁵ *As defined in Cranshaw et al. (2010) is the ratio of the number of space inhabitants against the study sample users*

3. METHODOLOGY

This section demonstrates the case study and the research methodology. The methodology used is based on datasets of two selected samples from the virtual space (twitter metrics) and the physical space (urban data and spatial configuration), then the data is visualised and analysed through qualitative and quantitative approaches.

3.1 Case Study

As a case study, Tech City is one of the densest clusters in London and has a strong reputation in the technology industry worldwide as the birth place of some of the key businesses on the Web (see Figure 5), including Last.fm and TweetDeck. Old Street and Shoreditch areas were the homes of a creative cluster in London accommodating galleries, dense with clubs and bars, architects, publishers and designers (Foord, 2013). The study area is highlighted in figure 6.

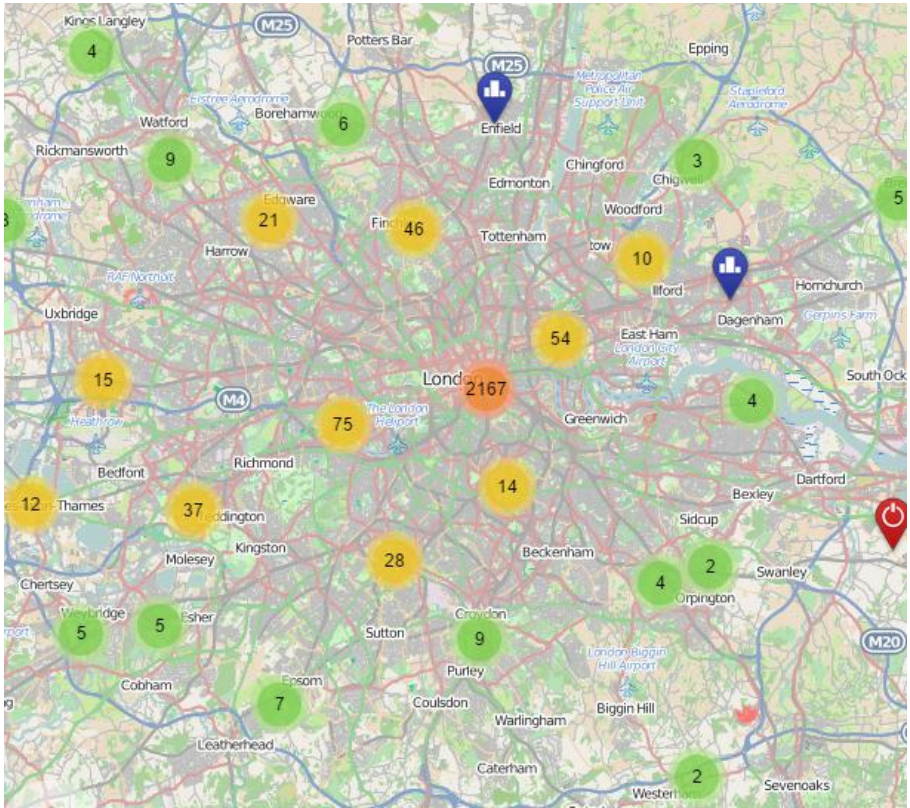


Figure 5 - London Map and the Study Zone Highlighted Orange (Techbritain.com, 2014)

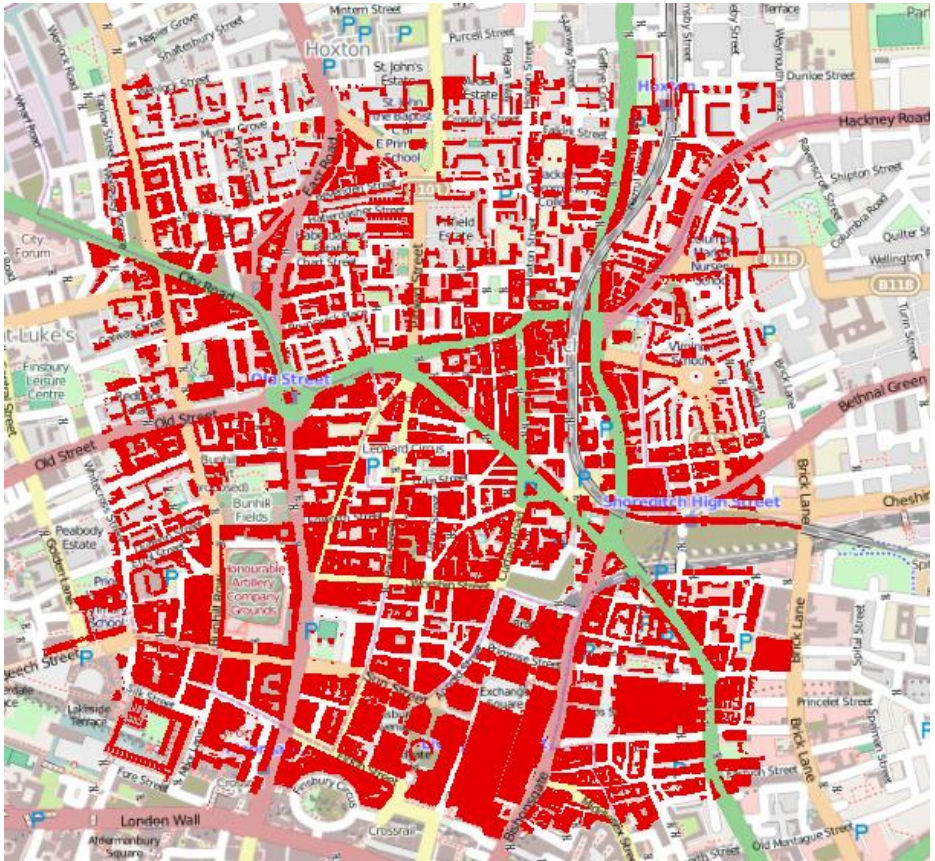


Figure 6 - The study area highlighted red.

The land use distribution and density vary in the study area. In the southern section there is a higher density of commercial properties, while residential properties dominate the northern section. However, most of the high rent areas are in the southern section, and prices decrease towards the north and slightly decrease towards the east.

As can be seen, the price increase has heavily affected the densest commercial cluster in the study area (see Figure 7); the average property price south of Old Street roundabout reaches an average of more than £664,000 pounds.

Legend

Average Property Prices

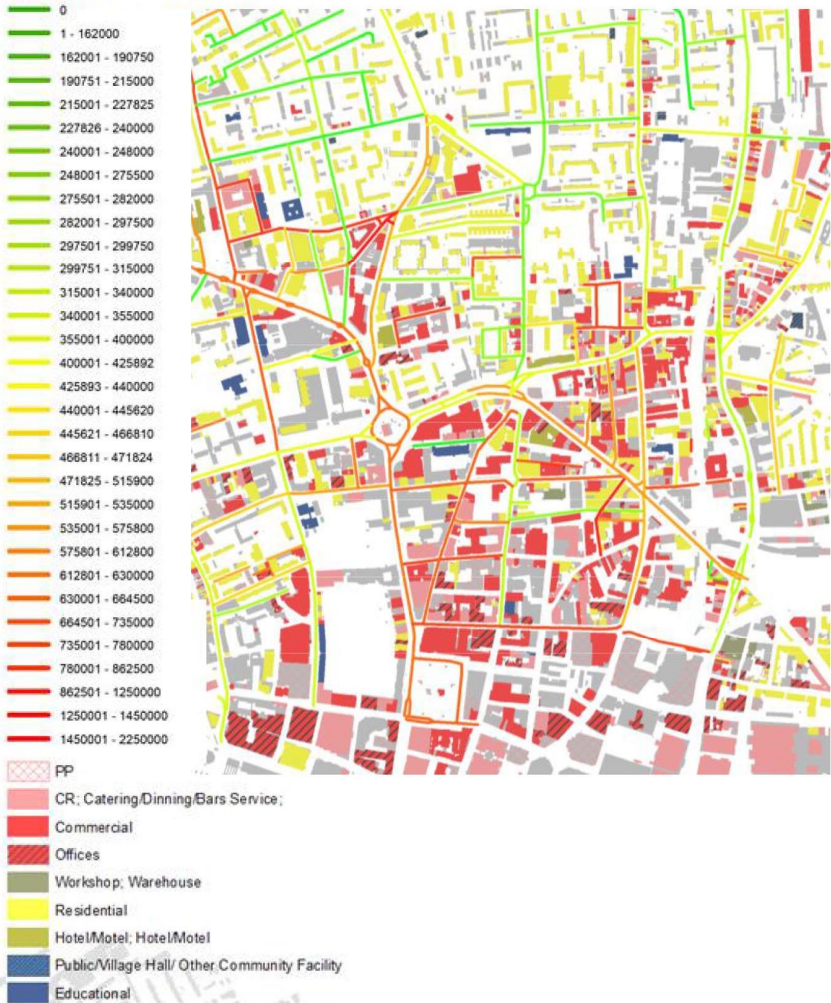


Figure 7 – Study Area Land Use and Average Property Values Map

3.2 Growth Environments and Tech City (Cluster Literature and Tech City Potentials)

As was identified by Daniel Isenberg in his article on starting an entrepreneurial revolution, which may seem to be the objective of Tech City, it was said:

“Governments around the world are recognizing that entrepreneurs can transform their economies. But most of their efforts to spark venture creation are wasted on trying to achieve the impossible-creating another Silicon Valley.”

(Isenberg, 2010:1)

According to Isenberg (2010), the face of entrepreneurship around the world has changed forever, and new influential start-ups are originating from unexpected locations. As quoted above, the power a start-up can add to the economy has been realized by many governments worldwide. As an example, his reference to Estonia's Skype as a start-up, and the Finnish game 'Angry Birds', which was acquired by larger companies for millions. Due to the emergence of these companies from unexpected locations, it was said that there is no formula for success in the entrepreneurial economy, 'only a practical road map' which is based on the factors in figure 8.

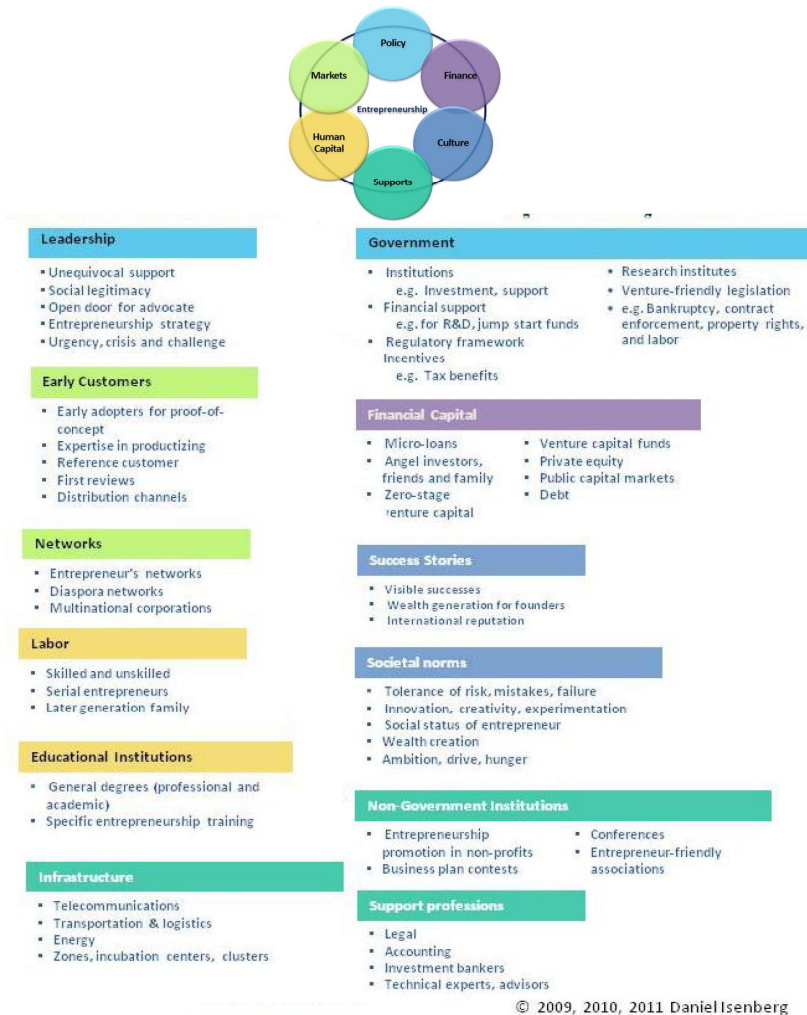


Figure 8- Domains of the Entrepreneurship Ecosystem (Edited) (Forbes, 2011)

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3.2 The Sampling Process and Companies Data

The largest accessible dataset of technology companies in the study area is techcitymap.com (see Appendix), where there is a list of companies with their Twitter accounts, their physical locations, and local Twitter metrics within the community. The target was to create a sample of a possible ecosystem within the specific study area. Starting from Tech City Map dataset, a list of 1472 companies with their Twitter metrics was used as a starting platform to select the 50 companies, which were then followed and cross-checked with other similar directories (see Figures, 9, 10, 11).

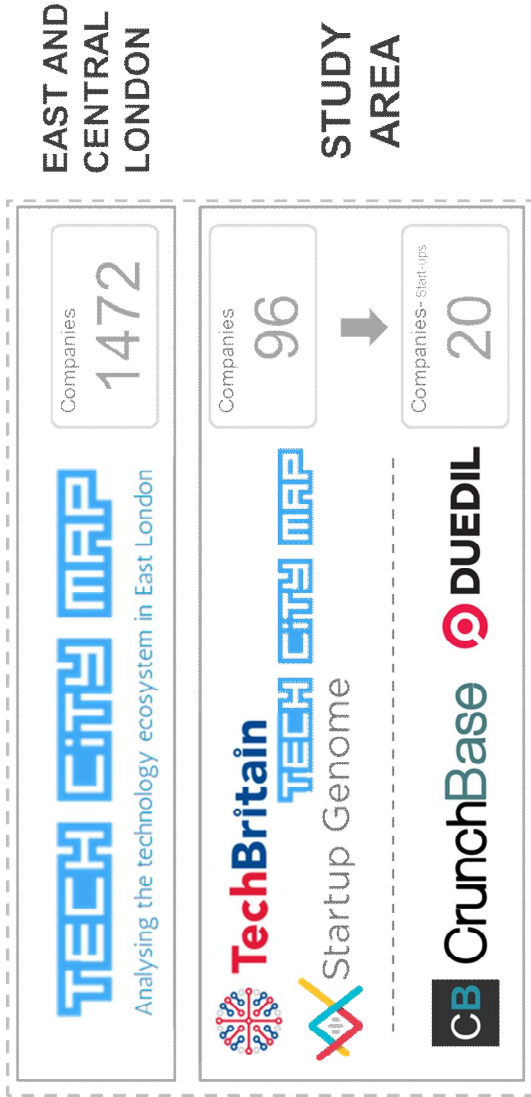


Figure 9- Source of Data and Samples

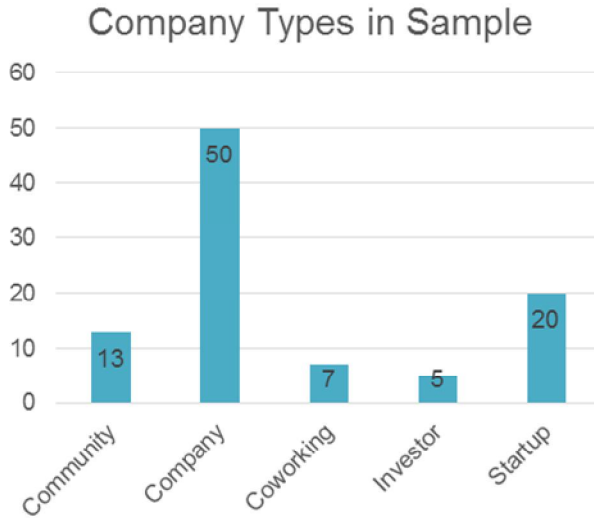
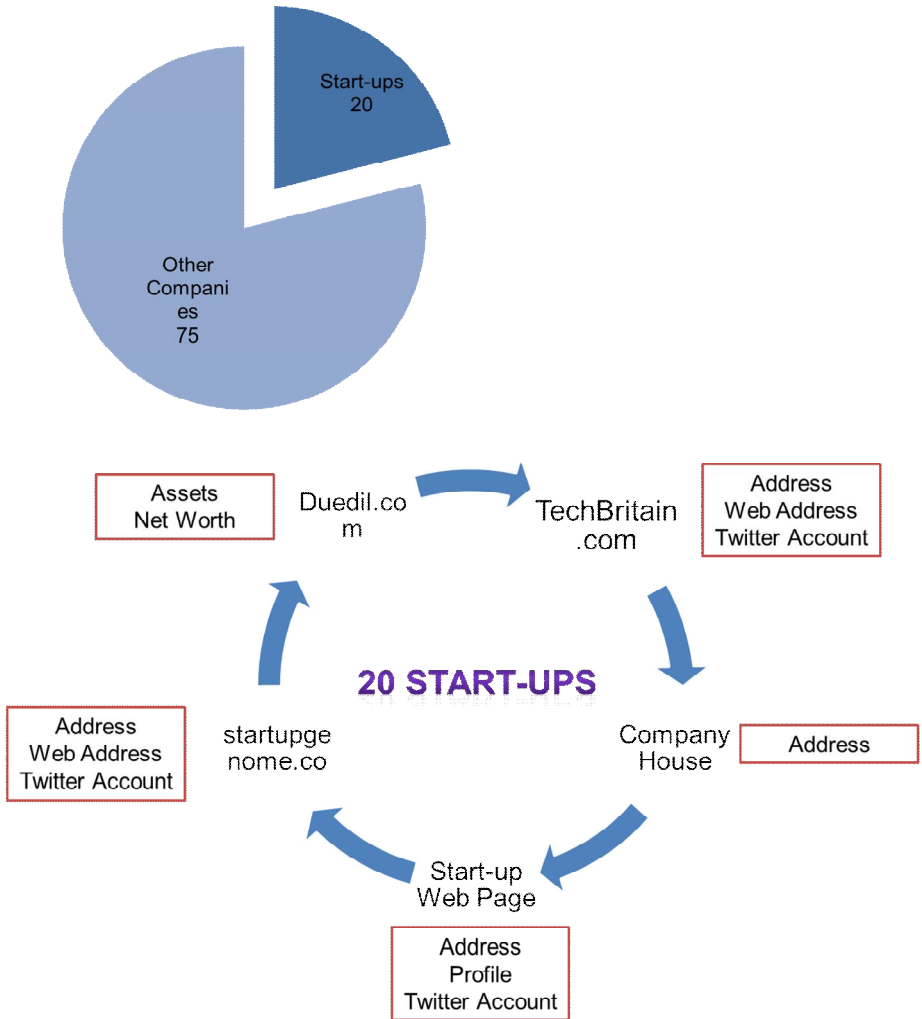


Figure 10 – The Company types in the Study Area Sample



(Figure 11 (part A). Data Building and Verification Processes)

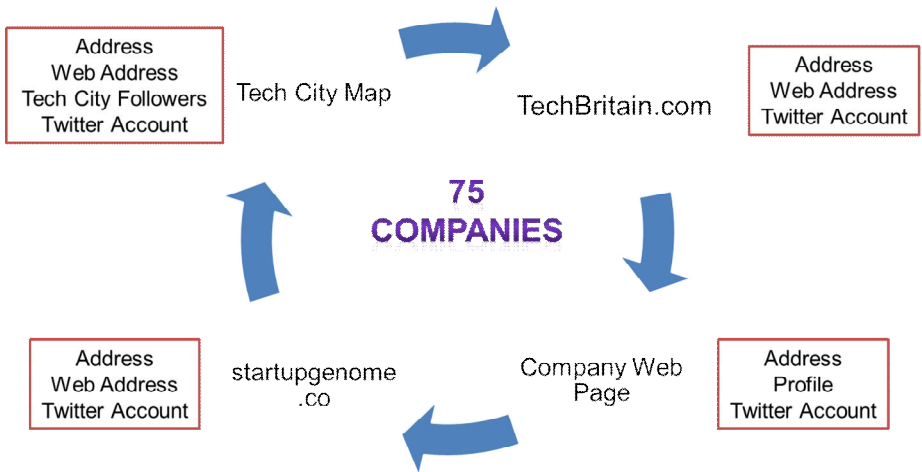


Figure 12 (part B). Data Building and Verification Processes

3.3 Twitter Relationships Visualization and Analysis Methodology

A list has been created of Twitter accounts of all the 1,472 companies in Tech City, with Twitter profiles data, using SocialBro.com⁶ Web services, which includes the number of followers, followees and Twitter activity rate. A second more detailed dataset has been created of specific clusters in the study area, with its own Twitter

⁶ *SocialBro is a popular social management website with a wide range of features and analytical reports.*

network data using the NodeXL⁷ Excel plugin, to determine Twitter relationships and calculate the Twitter local networks metrics (i.e. as in-degree, out-degree, degree, betweenness centrality and closeness centrality).

After creating the dataset of the local Twitter network (figure 12), the variables were analysed and visualized for further analysis using Gephi and GIS software or JMP (see the Appendix for more details). The final analysis is to go through the specific Twitter account activity using an online analysis service 'Twittonomy', providing a deeper analysis of individual users. This analysis lists the top ten users mentioned and replying, whilst also highlighting popular tweets and popular hashtags.

3.4 Urban Data and Spatial Configurations

The base layer urban data (i.e. postcodes, land-use and street name) for the study area was extracted from Ordnance Survey (OS) and AddressBase Plus services to ArcGIS compatible sets. The average property value data (in 4 years frame) was collected from the Land Registry website and then these datasets were linked through street names in the study area. A street was taken as an indicator of the street property value.

Through a dedicated set of tools, (UCL Depthmap)⁸, the configurational values for each spatial element of an architectural or

⁷ *NodeXL is a free and open-source social network analysis and visualization plug-in for Microsoft Excel 2007, 2010 and 2013 with social network data mining functionalities (nodexl.codeplex.com) (see Appendix).*

⁸ see Appendix

urban layout was computed. Space syntax offers different types of network-based models to represent space in a layout. One of these representations is the axial map. An axial map is the set of fewest and longest lines of sight that cover accessible space in a layout. A segment map is another type dual network representation, where each street inter-junctions is treated as a node and each intersection between two segments is a link.

To apply space syntax analysis on the case study, an axial map of 5km radius was extracted from the Space Syntax's 'London axial map'⁹. UCL Depthmap was used to run segment analysis. Data was then extracted to ArcGIS and linked to the street names, so it can be compared to other variables.

Configuration measures are related to social behaviour, and in this paper two key measures will be used: firstly integration, which is defined as the depth of each line/segment within the whole spatial network (which indicates to movement direct accessibility) (Hillier and Hanson, 1984:108); secondly choice, which can be defined as the likelihood of a line/segment for through movement potentials. The shortest paths in a network will have the highest through movement potentials and the highest choice values (Klarqvist, 1993). These definitions apply to topological measures of network distance. Angular measures of graph distance use some angular weighting to outline semi-continuous lines. The two main measures of angular segment analysis are angular weighted graph betweenness (choice), and angular weighted graph closeness (integration). These two indices were recently normalised to reduce the effect of network size; normalised angular choice (NACH), normalised angular integration

⁹ Source of data: Space syntax Ltd.

(NAIN). The normalisation followed a recently invented method that weighs the effort made by shortening journeys by the cost of segregation in the spatial network (Hillier et al, 2012). Angular indices were proven to be powerful at capturing vehicular and pedestrian movement potentials as well as at highlighting catchment areas for active economic centres (Hillier et al, 2012).

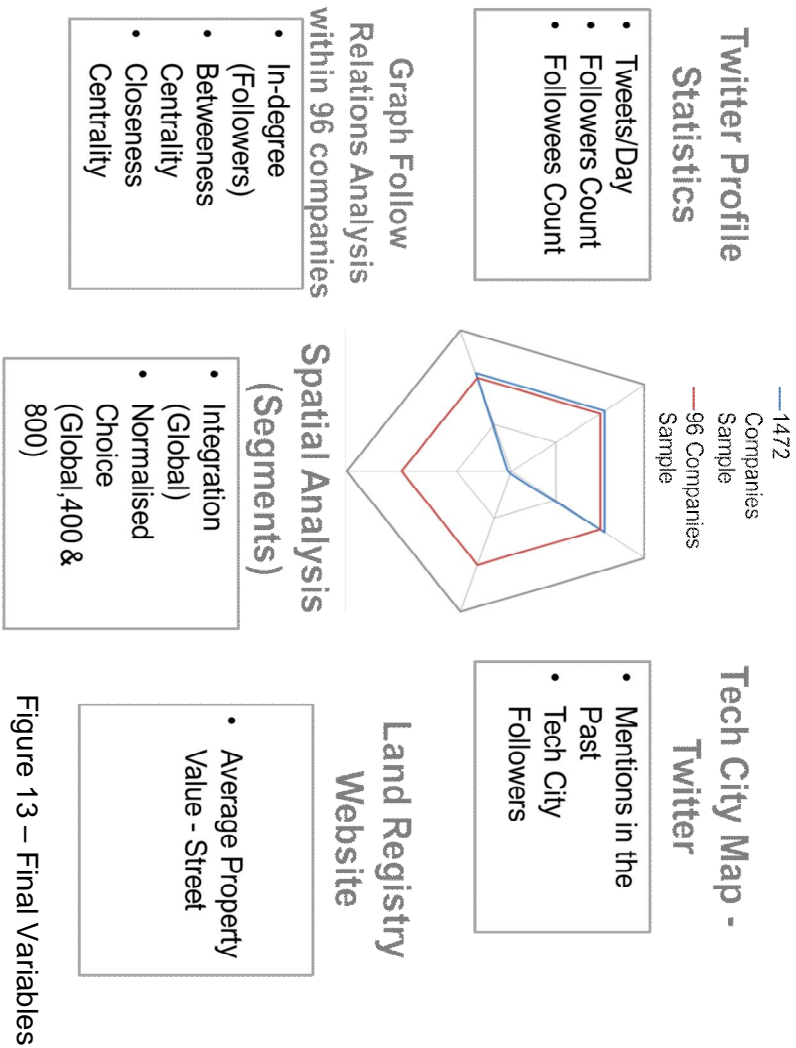


Figure 13 – Final Variables

3.5 Testing Process

After building the datasets (Figure 12), propositions are tested on the basis of quantitative and qualitative approaches. The datasets are first exported into JMP software to analyse the quantitative relationships between different variables. Twitter relationship patterns are then mapped and overlaid on the urban data for qualitative analysis. The analysis process is briefly illustrated in figure 13.

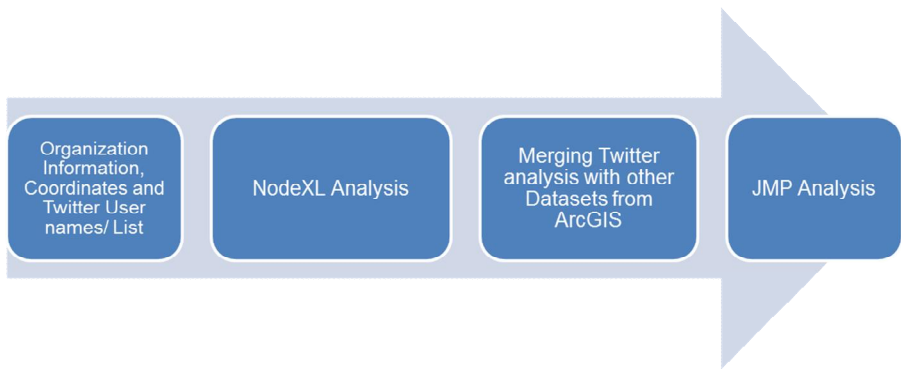


Figure 14 - A simple diagram of the analysis process

3.6 Analysis and Results

This includes the regression linear relationships analysis of the Twitter data of the first sample of 20 start-ups, and space syntax values using R-square values of the different variables, via JMP and Excel (check Appendix for further details).

Rsquare Values	Integration N	Nach N	Nach 400	Nach 800	Assets 2013
Tweets per day	0.052847	0.034384	0.050514	0.047771	0.001067
Followers	0.070679	0	0.004421	0.001915	0.259211
In-degree	0.12001	0.418976	0.516485	0.465311	0.069812
Closeness Centrality	0.000247	0.100549	0.129977	0.133776	0.157749
Betweenness Centrality	0.02881	0.016934	0.021461	0.022332	0.030705
Assets 2013	0.004235	0.010065	0.011984	0.020075	

Table 1 – Start-ups Spatial configurations and Twitter Analysis¹⁰

Rsquare Value	Integration N	Nach n	Nach 400	nach 800	followers	techcityfollowers
Tweets per day	0.000875	0.00468	0.007622	0.009154	0.092124	0.005333
TechCity Followers	0.028184	0.01292	0.004783	0.006154	0.08263	
Followers	0.000106	0.00712	0.017452	0.012768		0.08263
Indegree	0.000024	0.03226	0.046171	0.039765	0.014997	0.538067
techcity focus	0.025703	0.01085	0.002524	0.006992	0.006901	0.000076
Betweenness Centrality	0.001096	0.00491	0.009352	0.009266	0.003824	0.479831
Closeness Centrality	0.004141	0.00016	0.001928	0.001275	0.014532	0.231193

Table 2 – 96 companies sample Spatial configurations and Twitter Analysis

Rsquare Values	Tweets Per Day	TechCity Followers	Followers	InDegree
Tweets per day				
TechCity Followers	0.040121			
Followers	0.034089	0.073673		
Indegree	0.048717	0.524823	0.012554	

Table 3 – Tech City Scale (1472 companies) sample Analysis

Regression Analysis

On the start-ups scale there is a weak relationship between space syntax values and economic performance, number of followers, and

¹⁰ *This study included 20 start-ups, and was limited to 17 out of 20 observations, as three start-ups one had zero choice value and zero degree; one had relocated outside the study area and the other did not have a line within the segment map.*

Twitter Tech City's local configuration (See Tables 1-3). However, there is a moderate negative relationship between the number of local Tech City followers (In-degree) and normalized angular choice values peaking at 400 metre radius (see Figure 14). This shows that Tech City users in lower choice (through movement measure) areas have more followers from the sample. This means start-ups are more likely to choose areas with lower choice values within the street network. Tech City Map, based on graph modelling as in the previous example, is added to this map but in this case there are 96 parties overall, including start-ups.

Examining Tech City followers from techcitymap.com (see Tables 2 and 3), there is a higher correlation between the sample community followers and Tech City followers than there is between Tech City followers and the global scale followers.

On one hand this means that users who were of interest to the sample are more likely to be of interest to other technology start-ups within the larger Tech City. On the other hand, this could show that in Tech City, Twitter users have far more users with broader interests outside the geographical area of Tech City.

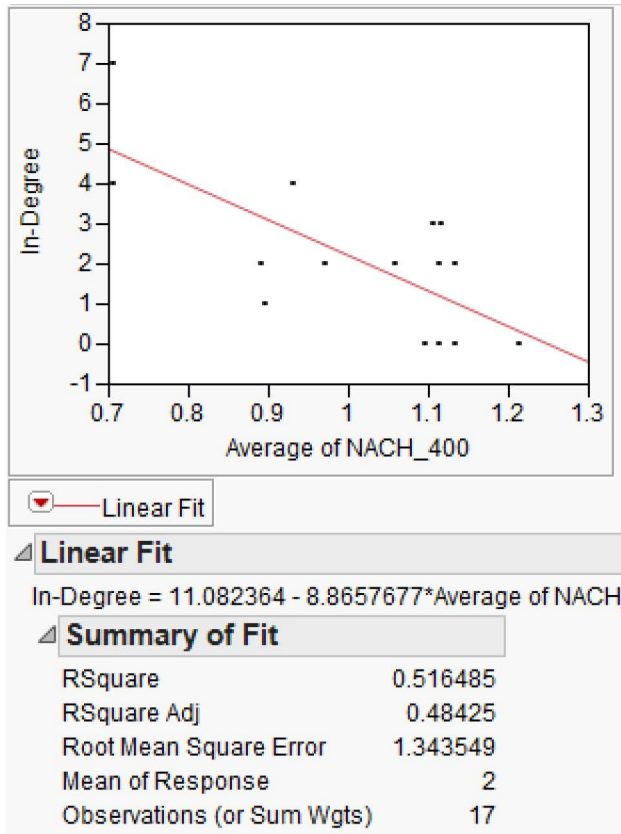
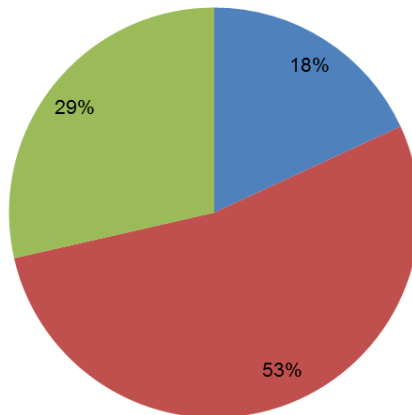


Figure 15 – Analysis of Start-up followers and NACH(r400)

Analysing mutual Followees

On analysing the number of followers of all 20 start-ups, the study area's central users can be found. After creating 20 sets of the start-ups' followee¹¹ lists, most of the top five common users were very active accounts with more than 100,000 followers. One exception is the username of an editor and TechCrunch's cofounder (Mike Butcher), who could be synonymous with TechCrunch but based in London. Within the set of users who had five or more mutual start-up users, about 29% were active users and at least 18% were Tech City users (see Figure 15). After examination of the data, Tech City users can be seen to have more mutual Tech City local followers and fewer Twitter global followers. After sorting Twitter users in order of the ratio of mutual start-ups' followers and total followers' count, six out of the first ten results were from Tech City London (see Figure 16).

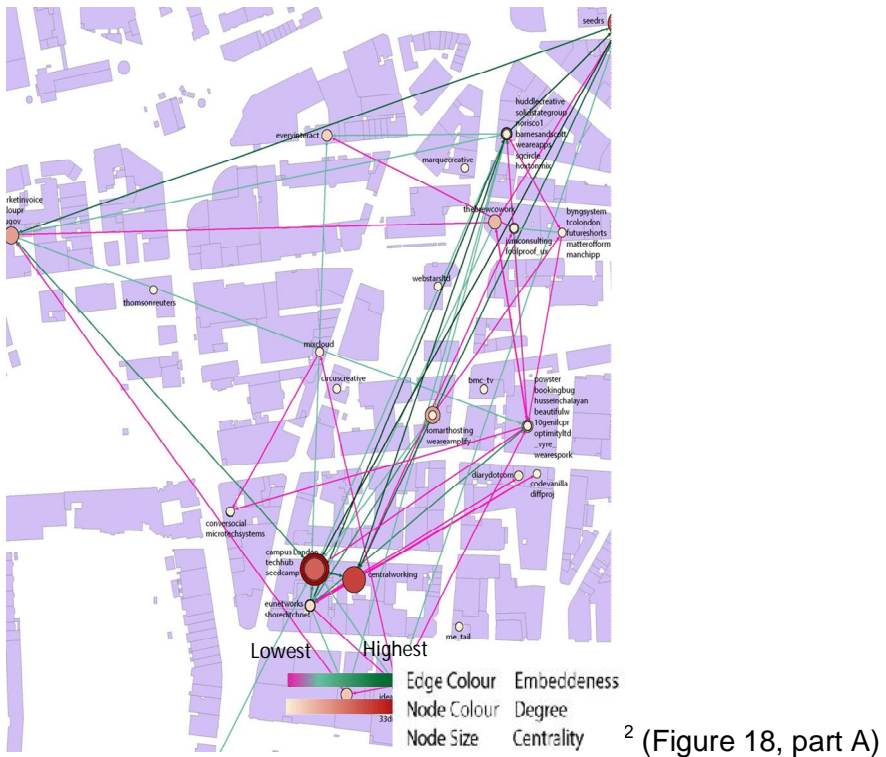
■ TechCity Users ■ Unknown ■ Active Users



¹¹ *Followees refer to those who are followed.*

Tech City Start-ups' Dynamics

Some earlier findings in this paper highlight patterns in the static behaviour of start-up businesses in relation to their physical location and status in the twitter community. The analysis suggested that most technology start-ups are located in streets which have relatively low accessibility rates (low choice and low integration values) in comparison to companies and IT services offices (figure 17 and 18).



¹² Embeddness: “of an edge in a network to be the number of common neighbors the two endpoints have.” (Easley and Kleinberg, 2010)

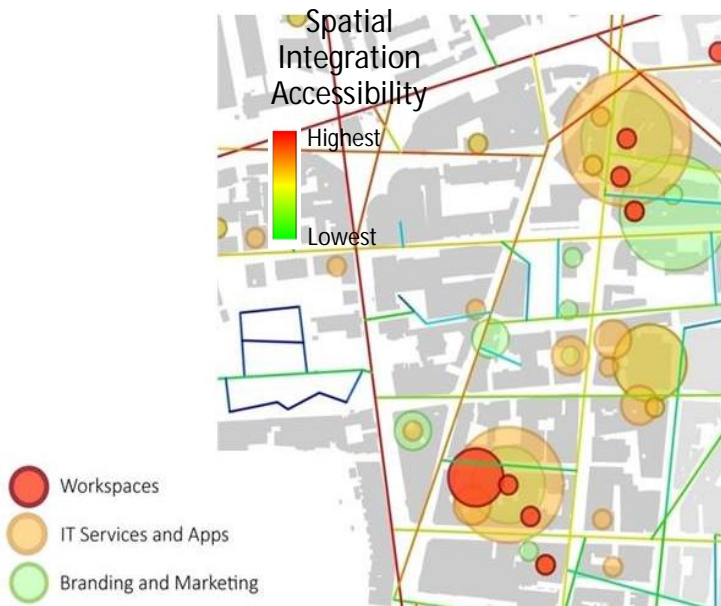


Figure 19 (part B) – The first part shows Twitter Network Analysis on a large sample of users’ relations compared to the second showing Office types and Accessibility (Spatial Integration) Values within the study area

The centrality of twitter networks of the sample start-ups and companies does not correlate with spatial centrality. As can be seen in figure 17, it can be said that centrality in the virtual network is more likely to be in areas where there is a high density of start-ups and venues than spatially integrated streets, yet there is a low to medium correlation which will be discussed further in this paper. Furthermore, community and event organisers tend to have many followers within Tech City companies and start-ups sample (figure 18).

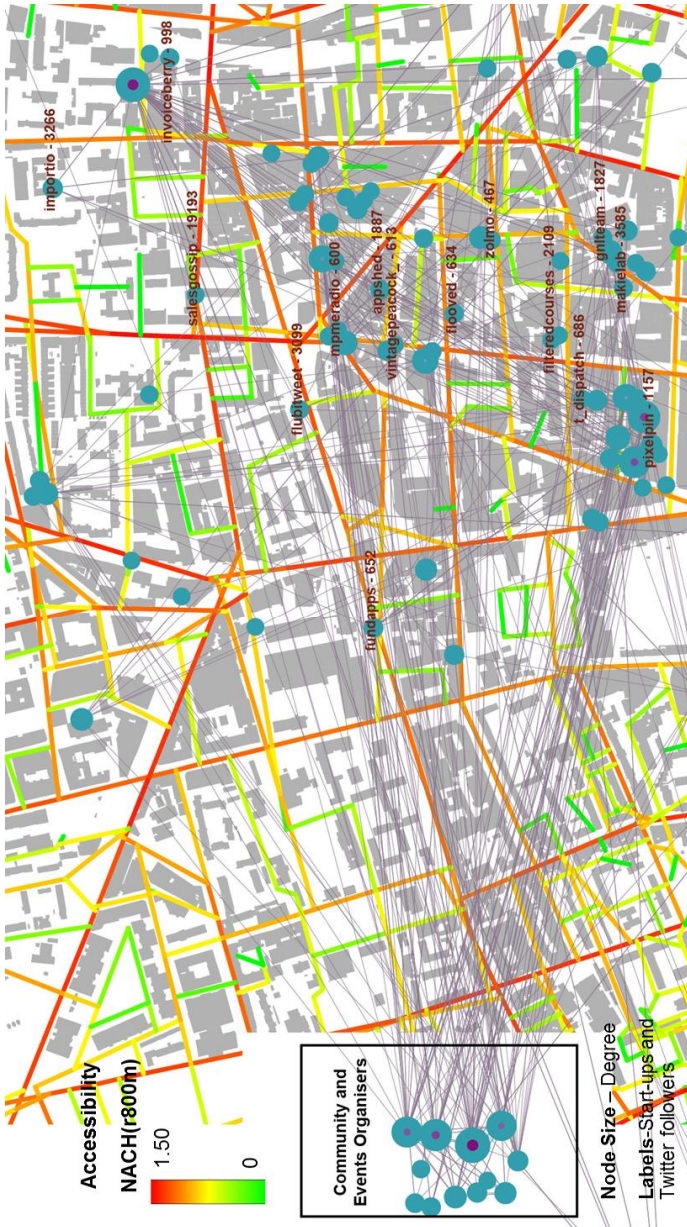


Figure 20 – NACH (r800m) Normalised Choice accessibility and the sampled Start-ups in the study area, the unlabelled nodes are workspaces and Tech companies

To reflect on the temporal dimension of their organisation in physical and virtual space, there is a need to trace their individual dynamics, hence we observe the behaviour of six start-ups in Tech City.

The analysis in (figure 19) suggests that after a period of their formation, five of the start-ups had moved to an area with higher choice value, although isolated from the rest of the clusters. Two start-ups, however, had moved to more expensive properties. We Are Apps Ltd had gone to more expensive property due to the company's interest in settling in a commercial shopping area (Soho) in order to be close to as many brands as possible, whereas in the case of Invoiceberry the start-up's move was towards a London metropolitan university accelerator space (Invoiceberry.com, 2011).

Further analysis of the six start-ups' interests, through hashtags and the favourite tweets ,as analysed by Twittonomy.com (2014), reveals that most of the hashtags used are centred on the product, offers and features only. For example, PixelPin was relatively better connected with local Tech City news and event organizers, which could be due to its repetitive appearance in the local media as a successful Tech City start-up. This case study has shown that the business type and status play an important role in the dynamics of Tech City start-ups, as well as land value and choice measures.



Import.io
is software which organizes and collects data from Web pages into exportable datasets.



PixelPin
is an Internet security service using personal pictures from PCs, phones and tablets for log-in authentication instead of passwords.



We Are Apps
is an application design and development service for PCs, tablets and smartphones.



Filtered Courses
is an online education platform that offers tailored training to individuals and businesses



Invoice berry
is an online invoicing service for small businesses and freelancers.



Move Guides is a cloud-based platform 'talent mobility software' for employee relocation and global mobility.

Company Name	Change in Integration N	Change in NACH 800	Change in NACH 400	Change in Street Property Value	Direction from main cluster
Import.io	-6%	24%	24%	-78%	Outwards
PixelPin	-20%	62%	59%	-23%	Inwards
We Are Apps	-2%	3%	1%	44%	Outwards
Filtered Courses	7%	27%	33%	-59%	Inwards
Invoiceberry	-150%	12%	13%	46%	-
Move Guides	33.48%	24%	34%	-37%	-

Company Name	Twitter Followers	Tech City Follower	Sample Followers	Tweets Per Day
Import.io	3266	5(0.15%)	2(0.06%)	4.79
PixelPin	1157	3(0.26%)	7(0.61%)	2.38
We Are Apps	304	8(2.63%)	0	0.97
Filtered Courses	2109	0	0	1.44
Invoiceberry	998	-	2	3.1
Move Guides	1611	-	2	4.85

Figure 21 – Six Start-ups' Dynamics Analysis

4. DISCUSSION

One of the key findings of this study of start-ups is the analysis of the relationships in physical life via the mutual followees study in the first section of the analysis; it shows that community and event organizer's accounts, where the community of Tech City is realized as a whole in the physical space, were also central in this study (see Figure 20). However, in the search for a relationship between the spatial configuration and position in the start-up focused sample of 96 users, a moderate negative correlation of $r = 0.51$ was found between normalized choice values and the number of the sample followers (20 start-up within a 96 users sample). The result may suggest that the ability to grow businesses in the virtual space enabled start-ups to choose segregated physical locations within the spatial structure of their locality, as these locations were cheaper to rent.

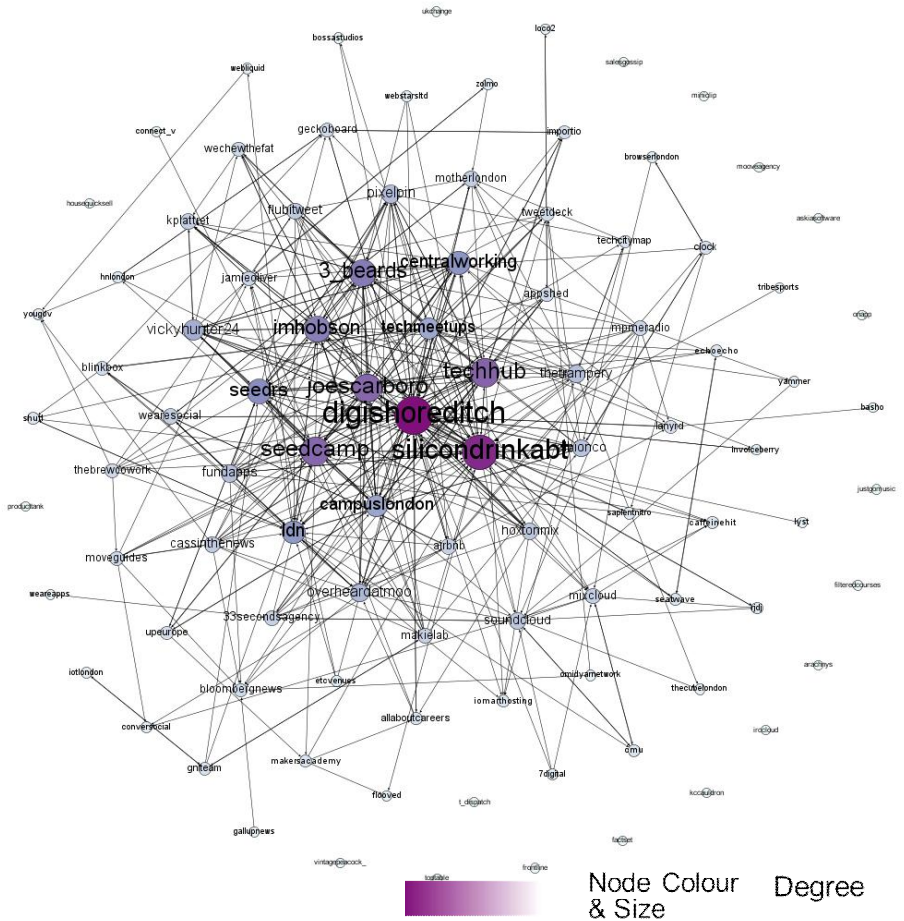


Figure 22 – The Study Sample (96 users) social network analysis (Fruchterman–Reingold Layout¹³)

¹³ As defined by wiki.gephi.org (2014) ‘The Fruchterman-Reingold Algorithm is a force-directed layout algorithm. The idea of a force directed layout algorithm is to consider a force between any two nodes. In this

The spatiality of the twitter community was not particularly strong. In general, there was a low degree of focus of the start-up accounts on neighbouring users in Tech City. The same finding was reflected again in the analysis of six users, which had shown a low focus in the sample and Tech City accounts list which was less than 2%.

Another limitation is the fact that most Tech City start-ups have limited financial resources, and the presence of other natively established businesses competing for similar office space forced many start-ups to relocate towards the cluster edges. Start-ups are limited to membership co-working spaces and existing warehouse style offices, which again restricts them to specific points within the overall study area. Secondly, as was shown earlier in the work of Huberman et al. (2008), the involvement of users in Twitter varies according to the level of Twitter engagement of their friends. In this case, it can be said that start-ups whose customers are from the Twitter public, as in the case of import.io, and sales conversations tend to be more focused and more active in the social network, thus the critical factor in determining the social network activity remaining under the engagement of parties of interest (such as customers, investors and community central figures), their business type and progress.

On tracing common followers in an attempt to find central figures in the study area, the common followees can be categorized into two categories according to their focus, whether it is in global or Tech City scale. The first group had international technology news blogs from different themes around technology, and the second constituted of

algorithm, the nodes are represented by steel rings and the edges are springs between them’.

Tech City specific news, local Tech City community and Tech City's event's key figures. The difference between the first and the second group is in the ratio of followees to followers, which is high in the first and low in the second. This ratio distribution can be explained as a typical local to global online popularity contrast. Start-ups rarely follow other start-ups (see Figure 21). Follow relationships are formulated by desirable media content. Therefore, if the Tech City virtual community had to exist it would be centred around Tech City news accounts, community groups, key investors, events organizers and would more likely to follow each other.

The results from the final analysis of the six accounts show that most of the tweets which originated from them are promoting their progress and products; this was, as can be assumed, the main objective of the Twitter accounts. In analysing the relocation pattern of the six start-ups, the destinations had remarkably lower property values and the change of spatial configuration (choice and integration) was increasing.

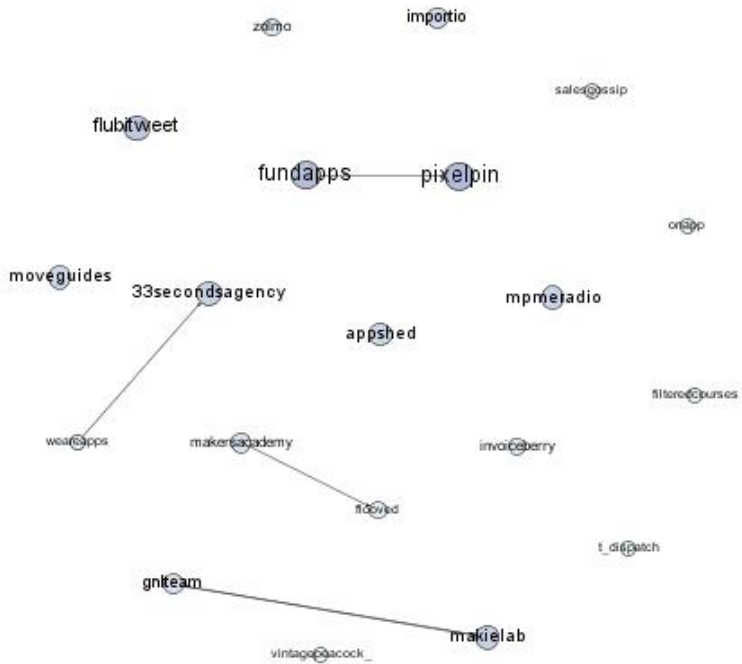


Figure 23 – Start-ups Follow Network

Previous research on the relationship between physical space and virtual space has had positive results. It was shown that virtual space is affected by physical distance, travel frequencies and language (Garcia-Gavilanes et al., 2014; Gruzd, 2011; Cranshaw, 2010). However, in the scale of the study area cluster, moderate to no correlations had been found between the spatial configurations, Twitter configuration, activity and start-ups' economic assets. Start-up

companies can be seen as individual, with distinct interests, but unified by common interests or goals.

One of the most controversial views on the social space was Castells' (1996) description of the virtual space as a 'space of flows' and his explanation of the virtual space as a new platform for trans-spatial relationships between societies which had not existed before (earlier societies were spatial and confined to their own borders – denoted a 'space of places'). The virtual space can be defined as a space of flows, but according to Castells the space of flows and the space of places do not intersect with each other, but rather create two parallel worlds. The findings of this present research confirm part of Castell's view, regarding the fluid characteristics of virtual space. However, our results disprove the claim that society's interaction in physical space and virtual space represent two parallel worlds, since we found that being central in virtual space does correspond with being central in physical space.

Theoretically, the way these two worlds intersect and link between users is manifested in how the individual socializes in urban areas. As pointed out in the Introduction, both virtual space and physical space might be decoded and encoded into a morphic language. Weissenborn (2010) showed that description retrieval is one of the most important components in morphic languages, which explains the way humans 'intuitively grasp' (Hillier and Hanson, 1984: 48) their position in artificial systems (as in cities and the Web clusters). Description retrieval is the mechanism by which Twitter users connect their standing in physical life to their life in the virtual world, bringing their interests and the reflection of physical interactions into the virtual space.

As described by Hillier and Netto (2002), in urbanized settlements the institutional space is the main sphere of each society and this space formulates the relationships of the individual through creating and controlling adequately large organizations for specific purposes. This definition of society in an urban space (as a reflexive society) is more consistent with the findings of this research. In the virtual space, individuals with common followees that have matching purposes or interests (as in the institution) tend to see the same contents and thus bring about a mutual information base which could equally influence these users. However, unlike that space there is no limit to the size of followers of an organization's page or the number of organizations in the virtual space; the only limitation is in the number of pages a user can fully track, depending on the time spent in Twitter and the activity of the followees, which leads some users to limit them. Therefore, as in the urban space, conceptual and spatial relationships can be carried into Twitter and can be spotted in the follow structure.

Framing the case under "aggregate complexity" (Mason, 2001:409), start-ups can be seen as part of a larger complex system a "whole" which is constituted of linked components inside the city. One of the objectives of Tech City was to build a Tech City community through creating a more flexible environment for self-organisation through creating a high co-presence of like-minded individuals from start-ups to established technology companies. This includes having a complex internal social structure where an individual can be a part of start-up workspace, a regular café visitor, active with start-up event organisers or a part of local club. However, according to the urban observations done earlier in the research, most of the non-member pedestrian activity was in the area that is central in twitter network analysis (Campus London building). Campus London accommodates two public floors which includes a café and meeting venues themed for

start-ups. There is a small share of the public space for start-ups in the study area; also most of the offices were parts of membership workspaces or rent spaces. In conclusion, it can be said that there is a spatial limitation which limits the chances for emerging relations and collaborations among the individuals who share the study area (particularly start-ups) in public and urban spaces.

Limitations

A major limitation was a result of Twitter's Search API which limits the number of requests and time frame of the data. This research would have benefited from studying a followers growth chart and the analysis of the growth of tweets over time before and after relocation. Secondly, although there were more than four directories; there was no consistency between them. The data quality of each was tested and the categorization in Tech Britain was used in this study.

Conclusion

This paper investigated a hypothetical relationship between configurations of urban space and the social network in Twitter, whilst also taking account of economic indicators that outline the performance of TechCity start-up businesses and property prices in the London boroughs where they cluster. The aim of this paper is two folds; to outline a global static pattern in how centrality in the Twitter network coincides with central and accessible spaces in the urban space, and outline a pattern in the individual dynamics of start-ups focusing in particular on the circumstances underlying the relocation of their businesses.

When looking at the global picture, we analysed Twitter networks separately and established their relationship with the configurations of street spaces property prices and land uses. After taking a sample of 96 users in Tech City, it was found that most of the start-ups within

the sample follow similar global influential pages as well as local community centres. Very few start-ups follow other start-ups in Tech City, and the follow relations in the start-up sample were mainly from, and centred on, community users. This can be explained by Twitter's fluid nature, being focused on the contents and encompassing primarily the company's operational interests, global interest and, finally, local interests including connections; however, the last could be visible to communities, as there is one community in the cluster, but less likely to appear in a random dispersed sample of 20 start-ups with 76 other active users. In spite of this, there is a moderate correlation of $R\text{-square} = 0.51$ between higher follow rates of start-ups in the sample and lower values of normalized choice. The relationship between start-ups locations and property prices is very weak for the sample under study.

When focusing on the temporal dimension of start-ups mobility, we found that -when relocating- start-ups would strategically choose to be closer to shortest paths, and often targets lower rent areas in the new locations. This is particularly evident for those with higher popularity and status in the virtual space – Twitter network. It is important to highlight here that this finding only holds for the six case studies that are investigated here.

As was indicated by Urry (2007), the mobility paradigms are actively circulating entities, including communicative and imaginative travel where there is a referential meaning added. The presence of the users on Twitter, as part of virtual travel, could be influenced by any of the circulating entities, such as movement of products or corporeal co-presence. The same conceptual society that is highly active had been visible from Twitter relations. On adapting the theoretical framework of Hillier and Hanson (1984) to explain the virtual space in

Tech City, Twitter proved to be a medium for conceptual relationships. These conceptual relationships were less likely to transfer into the physical sphere and manifest into spatial relationships. In addition, the number of restrictions on start-up choice of location within the cluster and Twitter's intricate interconnections made it difficult to distinguish a significant correspondence between activities in physical and virtual spaces. It is important to mention here that this result is only valid for the small sample that was analysed in this paper, and might therefore be vulnerable to the effect of outliers. In order to generalise our findings, there is a need to test our propositions on a larger case study, and perhaps compare our case to similar phenomena in different geographic locations.

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Appendix A

Glossary

ArcGIS - is a platform for designing and managing solutions through the application of geographic knowledge.

Betweenness Centrality – “is an indicator of a node's centrality in a network. It is equal to the number of shortest paths from all vertices to all others that pass through that node”. (Wikipedia, 2014)

Choice – is a spatial configuration measure of the through movement in a space. A space with higher choice value has a higher concentration of shortest paths through the whole network. (Hillier and Hanson, 1984).

Closeness Centrality – “is an important concept in social network analysis. In a graph representing a social network, closeness centrality measures how close a vertex is to all other vertices in the graph.” (Okamoto, Chen and Li, 2008).

Community - A community as defined by Turner (1986:84) is “the implicit law of wholeness arising out of relations between totalities” Turner had addressed an individual as a totality which cannot be a part of another totality.

Company House – is the official register of British companies, which includes director names, registered

address, change of registered address and change of directors history. Moreover, more statements can be bought online.

CrunchBase – a global database of technology companies and start-ups, which is run by TechCrunch.

DueDil – is a company dataset based on Company House data, which provide information about company’s yearly statements, directors and registered addresses.

Embeddness- “of an edge in a network to be the number of common neighbors the two endpoints have.” (Easley and Kleinberg, 2010)

Edges – is the line which connects on point in the graph to another.

Fruchterman–Reingold Layout - The Fruchterman-Reingold Algorithm is a force-directed algorithm, which sorts the nodes according to the force of their connections (Wiki.gephi.org, 2014).

Gephi– is graph visualization software which was created by students from University of Technology of Compiegne in France and the first release was July 2008. It has a dynamic and flexible interface where users can explore and interact visually with complex network visualizations. Gephi has wide library of styles, clustering algorithms and plug-ins. Its features include navigation, filtering and sorting network data through data tables. Gephi imports files from more than ten formats (including GEXF, GDF, GML and

GraphML) and it operates in Linux, Mac OS X and Windows.

Integration – is a spatial configuration measure of to movement in a space. A space with higher integration value is the easiest to get to (access). (Hillier and Hanson, 1984).

JMP- is a statistical software which is characterized by its graphical interface.

Nodes or Vertex – is the main units in which the graph is made.

NodeXL– (Network Overviewer for Discovery and Exploration in Excel) is network analysis and visualization software which was created by Marc Smith's team and the first release was in July 2008 (nodexl.codeplex.com/wikipage/history) and the project is run by the "Social Media Research Foundation" (NodeXL, 2014). It stores the social network data in an editable excel sheets (Vertices, Nodes, Groups..etc)(Bonsignore et al., 2009). NodeXL has its own library of network metrics calculations (such as degree, centrality and others) and a graph visualization feature (ibid). As many open source software, the data import and export feature from other network analysis software is superior and flexible; as NodeXL can work with GraphML, Pajek, UCINET and matrix formats (NodeXL, 2014).

Start-up – the tradition definition of a start-up is a company which is less than 3 years old. This definition does not apply to all start-ups. Another definition as reported from Adora Cheung in a Forbes article “Startup is a state of mind. It’s when people join your company and are still making the explicit decision to forgo stability in exchange for the promise of tremendous growth and the excitement of making immediate impact.” (Robehmed, 2013).

Twitter API– is a Twitter application programming interface (i.e. an interface on application mainly to edit and extract data).

- **Twitter Search API:** looks backwards for different queries (Hashtags, usernames or mentions) from the history of tweets roughly up to a week old. 1000 tweets to retrieved in one minute or two with a limit every 15 minutes. Requires less structure.
- **Twitter Streaming API:** Collects forward real-time stream data, requires time and structure background yet it is good for constructing bigger dataset and has a limit on the tweet rate delivery.

Twittonomy– Specialized Social Media analytics website with built-in. Extracts a list of the last 3200 tweets per user in an excel file or a pdf sheet. Filters and analyses tweets by date range. Analysis includes tweet frequency graphs in dates and hours, mentions pie charts of active mentions, popular hashtags, tweets and replies.

Virtual Community - 'social aggregations that emerge from the net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace' (Rheingold, 1993).