University of Southampton

Faculty of Environmental and Life Sciences

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Digital technology clusters and their built environments: an exploration of the significance of the local built environment for niche sector technology clusters.

by

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Abstract

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The aim of this thesis is to explore and develop an understanding of the microprocesses associated with digital technology clusters and their built environments. It poses the critical question as to whether the built environments of this new generation of businesses are fit for purpose? In the light of identified evidence and conceptual gaps at the local and granular scale of cluster exploration, the research creates an evidence base which emphasises the importance of recognizing niche technology sector working practices and information needs together with land management facets of the built environment if we are to progress our understanding of cluster behaviours and development needs.

A qualitative exploration of four UK case studies is undertaken, namely the digital games clusters in Guildford and London, and cybersecurity clusters in Malvern and London. It is based on primary interview and secondary property market and land use planning information. Three thematic analyses are undertaken which explore the significance of the built environment in terms of niche sector business co-location, localised face-to-face interactivity, and the interplay of cluster development with workspace property markets over time.

The research highlights the individuality of each of the four clusters. It shows how co-location and localised interactivity are a function of working practices and business cultures, afforded by the local built form and workspace property markets. Central to co-location is the strong association of niche sector businesses with workplace, which plays an emblematic role in terms of their identity. The strength of local niche sector face-to-face interactivity varies by cluster depending on how critical the need for certain information flows are to the respective business models. Dense built form, proximity to meet up and social spaces are shown to support these interactions. The general concept of local niche sector interactivity and associated knowledge flows are valued by respondents in all cases, but can be frustrated due to relative firm

isolation, the result of dispersed built form, inadequate transport connectivity and a limited degree of sectoral homogeneity of firms in the local business population. A timely supply of appropriate workspaces befitting business life-cycle stages is shown to be key to cluster development, which in turn is dependent on the status and responsiveness of the local workspace property market, combined with the modifying effects of the local land use planning system. The usefulness of a proposed built environmental -based model depicting the circle of causation of cluster development is confirmed.

The research advances the understanding of the cluster development of digital technology businesses. It confirms and reinforces the need to further our understanding of the localised nuances of both the business and property market dynamics of clusters, and highlights the potential of built environment based interventions to encourage cluster development.

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Research Thesis: Declaration of Authorship

Print name: Marion Payne

Title of thesis: Digital technology clusters and their built environments: an exploration of the significance of the local built environment for niche technology clusters.

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

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3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

Signature: .....Date: 15/3/21

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Definitions and Abbreviations

AONB.....Area of Outstanding Natural Beauty

BAFA.....British Arts Festival Association

CAZ .....Central Activities Zone

CEO.....chief executive officer

DCMS.....Department for Culture, Media and Sport

DERA.....Defence Evaluation and Research Agency

EVP .....Employee Value Proposition

FRI .....fully repairing and insuring (lease type)

GPT.....general purpose technology

ICT .....information communications and technology

iOS .....mobile phone operating system developed by Apple Inc.

LEP.....Local Economic Partnership

MHSP.....Malvern Hills Science Park

NIA.....net internal area

OWASP .....Open Web Application Security Project

RSRE.....Royal Signals and Radar Research Establishment

RRE .....Royal Research Establishment

SIC Codes.....Standard Industrial Classification Codes

SME .....small or medium-sized enterprise

TRE .....Telecoms Research Establishment

UKIE.....The association for UK Interactive Entertainment

VR .....virtual reality

WIC.....Wyche Innovation Centre

Chapter 1 Introduction

Digital technology industries are the fastest growing sector of the UK economy with the number of digital jobs and their input into the economy increasing year on year.[1] A characteristic of the industry is that it is becoming increasingly differentiated into niche sectors (Christensen, 2011; Lyubareva et al., 2014), some of which have a propensity to cluster (Tech City and Nesta, 2016).

The concept of clusters has become popular and spans various literatures. Accordingly, definitions of clusters and their featured characteristics vary (Lazzeretti et al., 2012), leading to criticisms related to the confused nature of the concept (Martin and Sunley, 2003) and measurement difficulties (Malmberg and Maskell, 2002). Clusters are recognisable as a critical mass of specialist businesses (for example Spencer et al., 2010). The physical proximity of the related businesses is seen as potentially assisting with localised face-to-face interactivity and the flow of tacit knowledge between them (for example Porter, 1998; McCann and Sheppard, 2003; Nathan and Vandore, 2014), which in turn may enhance competitiveness and innovation (for example Porter, 1998a; Gugler et al., 2015; Sölvell, 2015). In today's virtual world of doing business, the clustering of niche sector technology businesses is perhaps an enigma. The reasons are unclear. The body of research associated with niche sector digital clusters is limited, with studies variously alluding to a broad array of locational motivations including participating in specialist talent pools (Marshall, 1890; Pratt, 2011; Jones Lang La Salle, 2016), and the masculinisation of workplace preferences by the male-dominated IT industry (Massey, 1994; 1995). Furthermore, it is also unclear as to the importance of local face-to-face interactivity in these clusters, with some studies failing to recognise any such activity or benefits, (Gordon and McCann, 2000), which suggests that co-location could be being driven by other factors, including the effects of local context and place. There are a very few studies that suggest that local built form and the attractiveness of place may be of particular significance to niche sector technology businesses (Kotkin, 2000; Storper and Venables, 2004; Narvaez Zertuche and Davis, 2021). Cluster theory for too long has taken a generic focus on the business side of locational decisions (David et al., 1998; McCann and Sheppard, 2003). It has failed specifically to interrogate how the very niche sector working practices of digital technology businesses might affect their locational needs or balance this approach with developing an understanding of how the local context may affect these decisions. One of the reasons for this oversight has been the difficulties associated with recognising niche sector businesses, which escape the standard general industry classifications

[1] UK digital jobs: annual growth of 3.35% in 2004, 3.9% in 2012 and forecast to grow at 4.2% by 2022 (Office for National Statistics (ONS), 2015).

(section 2. 3). Furthermore, due to the paucity of case study research, the field is further frustrated by the lack of transferability of outputs and interpretations. This is the research gap which this study addresses . My overarching theoretical position is that “place” plays a more significant role in digital technology cluster development than has been hitherto recognised.

The research gap related to “place” is particularly pertinent today if we are to plan effectively for the emerging digital economy. At a similar time of economic transition in 1982, Stephen Fothergill and Graham Gudgin published their findings from a study of urban and regional employment change in post-war Britain, (Fothergill and Gudgin, 1982). The report found that the economy was stymied partially because of the dominance of large factory floorplates and the limited availability of affordable workspaces to suit nuanced local industry needs, despite councils providing what they thought were cheap and appropriate nursery units. We may well be facing similar planning issues today. Our “eye” may indeed have “gone off the ball” in terms of future-proofing the management of the new economy (Doel et al., 2014).

A better understanding needs to be developed of the microprocesses and dynamics associated with digital technology clusters and their contexts. Such an understanding would provide a much-needed point of departure for developing more sensitive and better-guided interventions to help clusters grow and develop (Huber, 2012a; Nathan and Overman, 2013; Doel et al., 2014; RTPI, 2016). Developing this evidence base is of particular importance for UK’s urban planners, who are tasked with dealing with the spatial aspects of the Government’s industrial strategy, as set out in the National Planning Policy Framework (NPPF) 2019. Critically, the Framework requires that,

> *Planning policies and decisions should recognise and address the specific locational requirements of different sectors. This includes making provision for clusters and networks of knowledge and data-driven, creative or high technology industries.*
> (Ministry of Housing, Communications and Local Government, 2019: 23)

There is currently little guidance or examples of “best practise” on how practitioners are to put the guidance into practice, undoubtedly due to the lack of research in this area. The built space interventions of the cyber security cluster in Malvern and digital games cluster in Guildford as described in this study, seem to be examples of a limited number of planned cluster interventions. The study by Segal Quince Wicksteed (1985) of an IT cluster in Cambridge is often cited in this thesis and stands out as the prime UK example of practitioner led research into this question. However, the study does not drill down into the needs of niche sector technology companies or attempt to understand their nuanced workplace demands, and thus thwarted the need for a granular and flexible response by planning practitioners.

Despite the irony of businesses working in substantially in a virtual environment having spatial preferences, this study is able to show that clustering niche sector technology businesses strongly identify with certain workplace environments. This affinity is shown to relate both to their sense of identity and also differentiating working practises and behaviours, including a reliance on very specialist talent, a customer focus and high company turnover rates, all of which point to the need for particular spatial solutions.

This study seeks to attend to this research gap and policy support vacuum by addressing three overall research objectives:

1. to enrich the evidence base of primary research into digital cluster development;
2. to develop a better understanding of the clustering characteristics of niche digital businesses; and
3. to evaluate the importance of the built environment to niche digital cluster development and its potential in terms of cluster intervention approaches.

The study has established several working definitions. Clusters are defined as:

a dynamic critical mass of co-located niche businesses exhibiting some degree of heightened levels of localised face-to-face interactivity.

This definition highlights the three identified key characteristics of clusters which are used to frame the study: co-location, localised face-to-face interactivity and dynamism. My personal definition of a digital technology cluster is a simple reapplication of the above general definition of a cluster :

a dynamic critical mass of co-located niche sector digital technology businesses exhibiting some degree of heightened levels of localised face-to-face interactivity.

“Place”, a core concept for the study, is defined as:

a locality which has developed a “specificity of institutions” and which may share common features across borders leading to “space distinctiveness” (Gertler 1997; Peck and Theodore, 2007).

The nebulous nature of the concept of “place” posed measurement difficulties for the study. These were resolved (Section 2.3) by focusing on the distinguishable facet of “place”, namely the built environment. The built environment is defined as “that sector of our physical environment that we modify through culturally determined behaviour” (Deetz, 1996). Its component parts or land management mechanisms provided a useful framework for the study are and are identified

as the property market, urban planning, and land-based financial measures and infrastructure, (Baudrillard, 2006; Lamprecht, 2016).

1.1 The theoretical hypothesis, research questions and approach

A purpose of the literature review is to drill down into what is known about the granularity of digital technology businesses, their working practises and how these impact their locational decisions, and what is known about the aspects of place that may be particularly pertinent to these decisions. A theoretical hypothesis is derived in section 2.5:

The built environment and associated property market institutions play an important role in the development of niche sector digital technology clusters.

Due to the lack of data in this research field, an exploratory approach is taken to the study, broadly investigating the relationship between niche sector business working practices and behaviours of clustering firms and their local built environments. Four case studies are included to represent two diverse niche sectors, the digital games industry and cybersecurity industry. Two research questions are developed which help to frame the study and focus the outputs on the study hypothesis:

- **How do niche sector technology business working practices and the built environmental features of place impact digital technology cluster characteristics?**

- **What are the features of the local built environment and property market institutions which afford or constrain digital technology cluster development?**

The rationale for the choice of case studies was to obtain a diversity of built environments. Digital games clusters were selected in Guildford and London (Clerkenwell) and cybersecurity clusters selected in Malvern and London (Shoreditch),[2] (Figure 1.1).

[2] The definition of the "digital games industry" is generally understood as comprising those firms which are producing games and associated software for computers, mobile phones and tablets. The cybersecurity niche sector is defined as the "protection of systems, networks and data in cyberspace" (www.itgovernance.co.uk).

Figure 1.1 Case-study cluster location in the UK

The primary data of the investigation comprised forty-one semi-structured interviews with key locational decision makers of representative sample businesses. The interview data was supported and corroborated with built environmental data, including property market statistics; planning policies; secondary interviews with planners, commercial agents and other built environmental professionals; and site visits. The interviews were undertaken between December 2018 and June 2019. Thereafter, three thematic analyses were undertaken, 1) the significance of the built environment on co-location; 2) the significance of the bult environment on local face-to-face interactivity and knowledge flows, and 3) the interplay between the clusters and their local property markets. The outputs are consolidated in the final chapter 7 in terms of the research questions and confirmation of the theoretical hypothesis.

1.2 The economic context of the study

The study is contextualised in terms of both economic and property market trends. The research interviews were undertaken just prior to the COVID-19 pandemic, reflecting a “relatively buoyant” economy and growth in the labour markets with unemployment at historically low rates. In

particular, 2018 saw a 0.6% expansion of the economy, the fastest growth rate in two years (ONS: GDP quarterly national accounts, UK: July to September 2018). However, towards the end of the survey period, growth and business investment started to decline due to Brexit-related uncertainties to a point where the economy was described as flat during Quarter 4 of 2019 and GDP growth rates were at their slowest since the financial crisis of 2008/2009 (ONS: GDP quarterly national accounts, UK: October to December 2019).

Both the Information, Communications and Technology (ICT) sector and the property market reflected these general economic trends. At the beginning of the study, ICT in the UK was continuing to attract more venture capital investment and stock market flotations than any other European country (Atradius Market Monitor, June 2019). As the period progressed, the uncertainties surrounding Brexit started to be felt and spending by British businesses on ICT and business process outsourcing (BPO) decreased 60% in 2018, to GBP 2.9 billion (down from GBP 5.1 billion in 2017), with companies delaying their tech investments due to the uncertainties. That said, the sharp decline in private sector spending was partly offset by a public sector investment surge of 68%, up to GBP 2.9 billion. Demand for office space remained broadly stable during 2018, during the fourth quarter of 2018 and the first of 2019, Brexit anticipation started to affect investor confidence and occupier decisions. This was reflected in some of the survey responses. Office rental growth was nuanced, albeit prime office rents were seen to rise across most regions. Secondary office rents however remained flat in the South-east and the Midlands, where the case studies were located. London rents, which tend to lead rental trends, were at the point where it looked like they might decline (RICS UK Commercial Property Market Survey, 2019). These market conditions were reflected in some of the interview responses.

1.3 Structure of the thesis and key chapter outputs

The thesis is presented in seven chapters described in outline below.

Chapter 1. Introduction

The introduction provides a background and overview of the thesis, including a summary presentation of the study's motivations, the overarching research aims and objectives, the hypothesis, research questions and a summary description of the research approach, context and structure.

Chapter 2. Literature review

The literature review presents the contextual background and an overview of cluster theory and identifies the lack of focus on the significance of "place". It continues by exploring what is known about digital technology clusters, recognising that the businesses have distinguishing working practices and spatial requirements. The final sections unpack the concepts of place and the dynamism of clusters and their contexts. The outputs are consolidated, enabling the generation of working definitions and the study's theoretical hypothesis.

Chapter 3. Methodology: the research approach and design

This chapter sets out a description and justification of the study approach and development of the research questions to frame the study. The case is made for a qualitative approach based on semi-structured interviews with key locational decision makers of niche sector digital technology firms, supported by bespoke local built environmental data and analysis. The choice of case studies is justified, as are the thematic analyses which are conducted through the lens of the case studies and designed to answer the research questions.

Chapter 4. Co-location in digital technology clusters and the significance of the built environment

This chapter presents the results of the first thematic analysis, exploring why the firms are co-locating and the effects of the built environment.

Chapter 5. Local face-to-face interactivity and knowledge flows in digital technology clusters and the significance of the built environment

This chapter presents the results of the second thematic analysis, exploring the importance and nature of local face-to-face interactivity and again, the role of the built environment.

Chapter 6. The interplay between digital technology clusters and their local property markets

This chapter presents the third thematic analysis, which explores how the workspace property market affects the development of the case study clusters.

Chapter 7. Study findings, contributions and conclusions

The outputs of the study are consolidated and the study's hypothesis is confirmed in this chapter. It highlights the significant contributions that the research findings make to debates and addressing gaps in the literature on digital cluster development, including the debate surrounding heterogenous and homogenous linkages and the function of "buzz" (section 2.2.3), the

significance of taking a dynamic approach in cluster research (section 2.2.4) and addressing the gap in the literature surrounding the role of place in cluster development. On the basis of the contributions of the study, cluster policy interventions are proposed. Finally the limitations of the study are described and possible future avenues for research identified.

1.4 Conclusions to the Introduction

The data-rich outputs of this original exploratory research provide an optimal springboard for more in-depth examination of several research fields, not least placing the built environment and the property market centre-stage for developing our understanding of cluster characteristics, thus providing a bridge to future cluster policy interventions The study is both novel and significant in that it re-establishes facets of place as having causative effects on cluster development, drawing attention specifically to the importance of built environmental form and the associated dynamic processes of land use planning, property market information flows and its responsiveness to business demands.

Chapter 2 Literature Review

2.1 Introduction

The purpose of this literature review is to provide context and direction for the study. It is presented in three major sections, each exploring one of the study's central concepts, clusters, digital clusters and place. In so doing it presents working definitions, key theoretical arguments and the gaps in the literatures relevant to each. The final section pulls the outputs together, confirming the main gaps in the literature for the study to attend to, then developing a theoretical explanatory model which is used to generate the study hypothesis, approach and guiding research questions.

2.2 What is a cluster? What the literature tells us

According to the OED (fourth edition), a cluster " is a group of similar things", yet cluster theory is less clear on a definition. Cluster theory has developed from a mix of disciplines including economics, economic geography, urban planning and strategic management. The resultant literature base is broad and rich, providing a truly "multi-perspectival approach" (Benneworth and Henry, 2004: 1012) to a spatial economic phenomenon. However it has also created problems, in that the focus of cluster theory has been taken in various directions, which sometimes overlap, working together and influencing each other, and at other times do not. The cluster concept is fragmented, which has caused difficulties for researchers and policymakers alike, with only a few authors attempting to draw the literatures together to find common ground, (for example Asheim et al., 2006; Vorley, 2008; Martin and Sunley, 2003; Maskell and Kebir, 2006). In the work of Asheim et al. (2006) they helpfully develop five theoretical perspectives of cluster theory which have been adopted and updated and used as a framework for this review, albeit with a "health warning" that the delineation between theoretical perspectives and academic discipline is not always "black and white". Table 2.1 summarises the key perspectives by academic discipline, together with indicative dates for broad context – although the school of thinking may well have started earlier and continued later.

Main period of academic output	Cross-discipline theoretical perspectives (after Asheim et al., 2006)	Key cluster concept contributions by academic discipline		
		Economic literature	Strategic management literature	Economic geography literature
1801–1955	Classical industrial location models	Industrial districts; Industrial location models		
1970s	Italian neo-Marshallian industrial economics	Third Italy literature		Third Italy
1980s	New Trade theory and Marshallian localisation economics	Role of knowledge flows in competitive economies Agglomeration economics	Strategic Network Theory	New Economic Geography
1990s	New endogenous growth theory	Urban variety view of clusters Relationships and networks		New Economic Growth Theory
1980s/1990s	Economics of firm strategy and Marshallian localisation economics		Clusters and Competitiveness, based on the work by Michael Porter	Neo-Marshallian localisation
2000s	Urban economics	Cities and urban economics	Post-Porter	Urban economic geography
Later 2000s to present	Neo-Schumpeterian and evolutionary economics	Evolutionary economics	Entrepreneurship	Evolutionary economic geography

Table 2.1 Broad history of the cluster concept

Tables chronologically summarising the key contributory works in each field of research by academic discipline are provided in Appendix A. In addition to summarising the main contributions and criticisms, the tables help to highlight the complexity of the literature and the plethora of definitions and cluster type models, each with slightly differing contexts and backgrounds (Maskell and Kebir, 2006). These issues are compounded in that, relative to the size of the literature, there are few extensive and statistical empirical studies (Graham, 1986; Boschma, 2005; Nathan and Overman, 2013). This has led to definitional confusion, unresolved academic debates and generally slow progress in developing a workable understanding of the clustering phenomenon (Martin and Sunley, 2003; Malmberg, 2002; Vorley, 2008), which is unhelpful for this study. To overcome the problem, the next section delves into what we know

about the characteristics of clusters in order to settle on a definitional basis for the study and to help with setting up the framework for the study.

2.2.1 The characteristics and a definition of a cluster

Despite the litany of cluster type models and definitions, as highlighted in Appendix A, it is possible to identify three common cluster characteristics: they exhibit a critical mass of co-located specialised industries; there is some degree of local interactivity and knowledge exchange assumed to be through face-to-face interaction between businesses and; as more recently recognised in the neo-Italian and evolutionary economic work, clusters are dynamic and associated with micro developmental processes (Uyarra and Ramlogan, 2012). Taking these characteristics on board, a suitable working definition of a cluster for this study is:

a dynamic critical mass of co-located niche businesses exhibiting heightened levels of localised, mainly face-to-face interactivity.

It is likely that most clusters exhibit these characteristics, but to differing degrees, such that each cluster will be uniquely constituted. Figure 2.1 below demonstrates the potential for individualism of clusters based on the combined effects of differing intensities (hypothetical scale 1 = low, 5 = high) of the three characteristics.

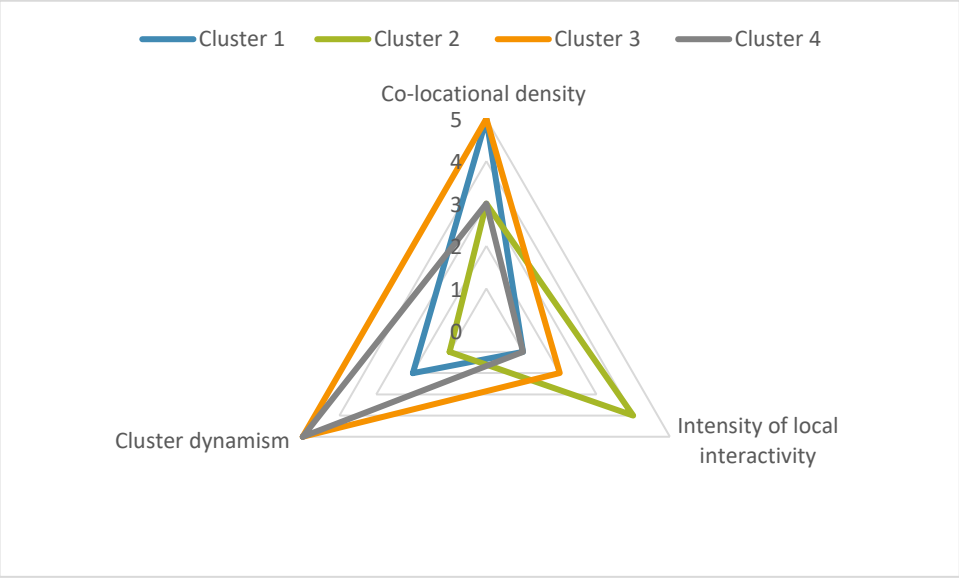


Figure 2.1 The potential for differential cluster characterisation

For example, a highly dynamic, physically proximate cluster, with high levels of connectivity, will be represented at the apex of the figure, whilst a dynamic, proximate but less locally interactive cluster will be in the left-hand corner. The models show how clusters may exhibit blended characteristics on a continuum from being highly interactive to simply a non-interactive

agglomeration of specialist businesses. The question arises: why do these differentials exist? To achieve an understanding, we need to delve into the microprocesses associated with these cluster characteristics. The following sections present what is known in cluster theory about each one, the theoretical debates and research gaps, providing context and guidance for developing the study.

2.2.2 The microprocesses associated with co-location

The characteristic of co-location in clusters has varied throughout the literature both in terms of scale and an understanding of what is meant by "proximity" between businesses. Proximity and co-location is a relative characteristic within clusters, dependent on the spatial scale of the cluster (as demonstrated in Appendix A). In the early industrial district models of Marshall, local agglomerations were recognised, businesses being within walking distance of each other. Business locational decisions were understood to be the result of both working practice needs as provided for in the local context and the "idiosyncrasies of place" (Marshall, 1930: 266).

Thereafter the emphasis of the literature changes. Marshall turned his attention to demand economies, emphasising how a pool of skilled labour, the growth of supporting industries, and the exchange and sharing of knowledge, are responsible for the localisation processes. These externalities were then embraced by the pursuant literature. For example, the "Third Italy" body of work, whilst being the first to map clusters, focused on the labour pool, local cultures and social practice benefits of agglomeration (for example Florence, 1957; Bagnasco, 1977; Becattini, 1987, 1990; Brusco, 1992; Camagni, 1994). Co-location was assumed to be driven by business decisions with little balanced interrogation of the microprocesses that might be at large. The next body of literature, New Trade theory, which came out of Strategic Network theory, concentrated on knowledge flows and networks in the context of the goals of generally improving business innovation and competitiveness. A regional bias emerged in the 1980's in the geographical literature as "relational theory", which further removed clusters from their local contexts. Co-location was now seen to be about much greater distances between firms, and was identified through the use of location quotients,[3] a relative measure of specialist firm concentration within a specified region. Michael Porter's work was set in this context and credited for the popularising of the cluster concept (Martin and Sunley, 2003). Porter's definition of a cluster was popularly adopted:

[3] Location quotients measure the concentration of an industry within an area. They are typically constructed using data on employment by industry. For a given area, the location quotient for industry i is:

$$LQi = \frac{\%\text{ of area employed in industry i}}{\text{National \% employed in industry i}}$$ (McMillen, 2005)

> *a geographic concentration of interconnected businesses, specialized suppliers, service providers, firms in related industries and associated institutions (for example, universities, regulatory agencies and trade associations) in particular fields that compete but also cooperate.* (Porter, 1998b: 213–214)

Clusters were being identified through business relationships, and Porter's ideas of proximity could be "geographic, cultural and institutional" and based on personal relationships and trust, facilitated by localisation which in his work was generally on the regional scale (Huggins and Izushi, 2011: 11). Porter's popular analytical Diamond Framework highlights his recognition of "local"/input factors (Figure 2.2), which affect the cost drivers and competitiveness of business.

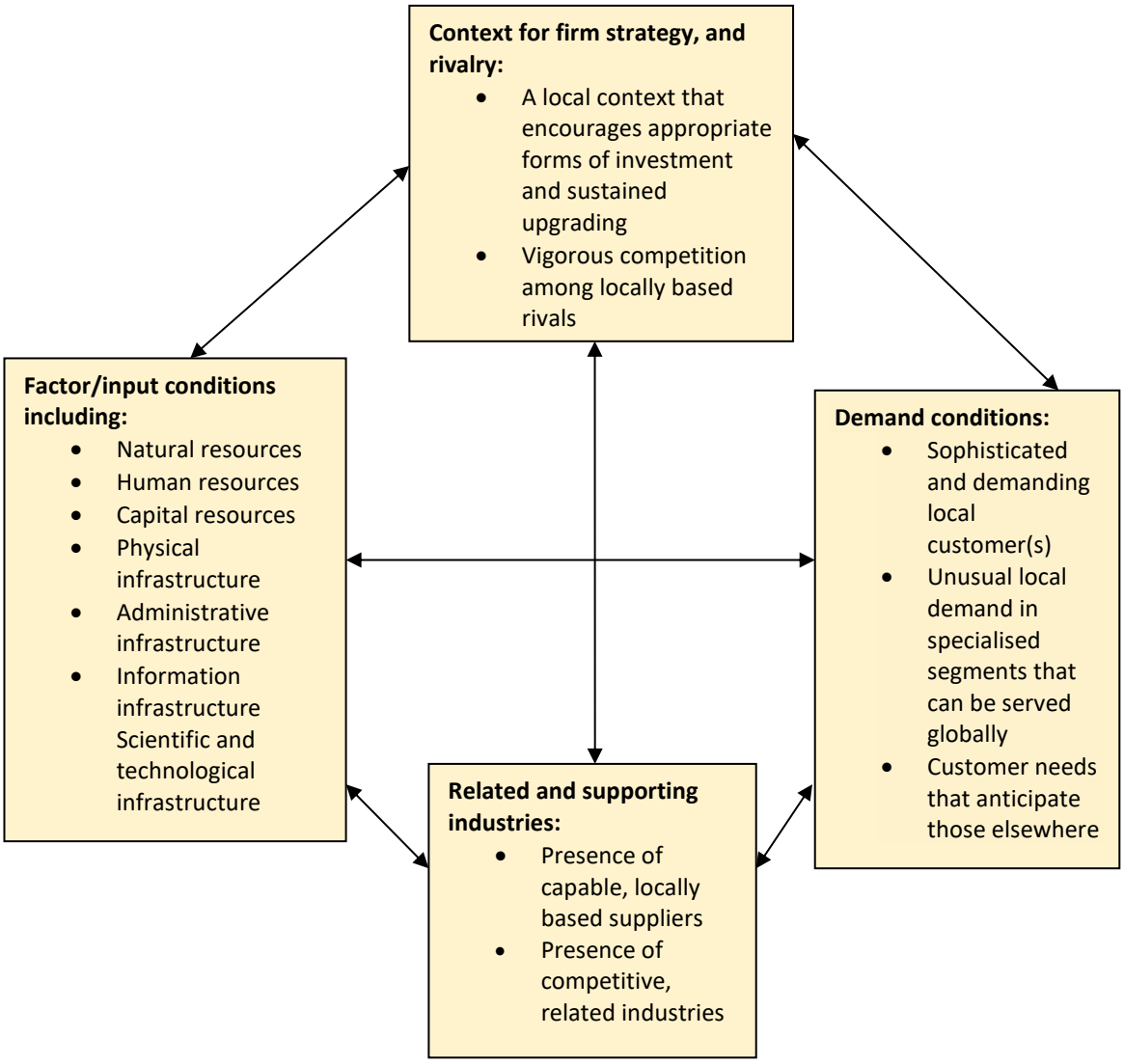


Figure 2.2 Porter's Diamond Framework applied to locational competitive advantage (Porter, 2000a)

If Porter's Diamond is used in the manner intended, it actually incorporated a more balanced look at clusters albeit at a regional scale. Interestingly, despite the usual presentation of Porter as a strategic management guru emphasising business needs, he is a fan of geography, and personally lamented that the role of location in cluster analysis "has been long overlooked" (Porter, 1998b: 78). However, these insights were overlooked by many and Porter and his associates were criticised for their lack of attention to the primary forces behind co-location (McCann and Sheppard, 2003). Duranton (2011), highlighting this academic oversight, observed that, "since the relative location of clusters and relative locations within clusters are not prominent concerns in the literature, we can ignore these issues and make the simplest possible assumptions about the internal and external geography of clusters" (Duranton, 2011: 8). It seems that for many years the presumption was that co-location by specialist businesses was the spatial result of businesses seeking competitive advantage through knowledge spillovers (Maskell and Malmberg, 2002), but in fact they failed to discern whether these outputs were the cause or the effect of business locational decisions.

It could be that this criticism was the turning point in cluster theory where the need to redress the balance regarding supply-side economies and their effect on co-location started to be acknowledged. We see how the New Economic Geographers, whilst focusing on the role of clusters and knowledge flows in the production cycle (for example Storper and Venables, 2004; Giuliani, 2007), started to notice differences between clusters and the density of networks in urban and more peripheral areas (a reflection on the density of networks, see for example Tődtling, 1992). The emphasis was now on urban clusters, rather than more peripheral clusters. A literature which had been growing since the days of the "Chicago School" in the 1960s was mainly interested in trade and the integral role of knowledge flows (Goddard, 1968; Jacobs, 1969). This work developed in parallel to the work by New Endogenous Growth theorists, in which cities and their density of actors were assumed to be efficient mechanisms for knowledge transmission (Krugman, 1991b; Storper and Venables, 2004; Scott, 2001; Johnson et al., 2002). Whilst spatial scale was starting to be reduced to that of the locale once again, it remained heavily biased towards the exploration of local face-to-face interactivity and the effectiveness of clusters as a mechanism for "sticky" tacit knowledge flows (Scott, 2001; Polanyi, 1966; Nelson and Winter, 1982; Gertler, 2003; Storper and Venables, 2004).

It is only more recently with the adoption of an evolutionary approach to economic geography that cluster theory has started to take a new, more integrative direction. The approach rekindles the institutional models of North (1990: 3). North defined institutions as "the rules of the game in a society… the humanly devised constraints that shape human interaction". The approach recognises that the spatial outcome of economic change is the resultant sum of both the

behaviours of firms and the influence of the socioeconomic landscape in which they are located (Nelson and Winter, 1982; Lambooy, 1989; Dopfer et al., 2004; Boschma and Ter Wal, 2007). The local juxtaposition of businesses mostly within walking distance of each other is once again recognised, with a regained focus on the microprocesses and nuances involved with business working practices and their contexts (Boschma and Martin, 2010).

A separate literature, which has had little overlap with cluster theory is Industrial location Theory[4]. By definition, understanding business location is central to this study and has been classically related to factors such as proximity to public transport, raw materials and customers. More recent research adds complexity to these early ideas, recognising that differences between firms in terms of their size, sector, culture (Walker, 2003) and environmental preferences (McCann and Sheppard, 2006) affect their locational decision-making processes. A variety of potential causal co-locational drivers are being identified. For example, Simmie et al. (2002) recognised the importance of international transport connectivity in creating a local trading cluster around Heathrow airport, whilst Champion (2014) described the preference of creative studios in Manchester for locating close to the central railway station, and hence having closer connectivity to markets in London. Attention has also turned to the locational attraction of cultural hubs (Falck et al., 2011) and universities (Cooke et al., 2007; Reveiu and Dardal, 2013), as well as built environmental factors, the subject of Section 2.4, and more intangible locational factors, which appear to relate to our digital age and are dealt with in Section 2.3. Overall, business locational decisions involve a strategic business process which balances the costs and benefits of location, yet we know little about the influences on this strategic business decision in respect of clustering businesses. Very few cluster studies have taken an industrial locational approach to cluster development to the detriment of the development of cluster theory as a whole (McCann and Sheppard, 2003).

2.2.3 The microprocesses associated with local face-to-face interactivity and knowledge flows

Clusters are traditionally associated with the flow of tacit knowledge, i.e., non-codified information, which is most effectively transmitted through face-to-face meet-ups and interactivity (Polanyi, 1966; Balconi, 2002; Gertler, 2003). However, as with “co-location”, “local face-to-face interactivity” is presented variously throughout cluster theory. The tables presented in annex A summarise the focus of each of the cluster models. It is noticeable that the emphasis of the models and their functionalities vary significantly. Whilst knowledge flows are often central to the

[4] See Hamilton (1967) for a useful overview of the subject.

models, as with “co-location” the associated mechanics are rarely interrogated. There is a central presumption that proximity will facilitate these flows, often through serendipitous meetings through local pavement and small-block geography (Jacobs, 1969; 1992). Meetings may also be social or semi-formal, (Storper, 2013), afforded by what has been described as the “extended workplace” of the local neighbourhood, in bars, restaurants and open spaces (Martins, 2015).

The nature of the interactivity can to some extent be discerned from the various cluster models and their functionalities. Industrial district models were seen as labour pool mechanisms, with proximity between employers and employees presumably facilitating the flows of employment related tacit knowledge (Marshall, 1890; Pratt, 2011). Pratt (2011), in comparing new media and digital games clusters in San Francisco, highlights the importance of the “talent pool” effect of both, displaying high levels of local interactivity and associated information flows. Due to the prevalence of short employment contracts, firms were clustering such that they would be in the “know” about employment related information. At the same time the insecurity of these scarce workers meant that they would be attracted to work in a place that offered a multitude of working possibilities. Interactivity levels between firms are correspondingly high, but the mechanism for this local interactivity is not probed. Other cluster models emphasise other benefits of localised information exchange, at the heart of which are assumptions of specific interactions but little on the mechanics of the interactions. In supply chain–led clusters (for example Schumpeter, 1934; Simmie and Sennet, 1999; Perry and Sohal, 2001; Storper and Venables, 2004; Mudambi, 2008; Chapman, 2014), the cluster-enhancing relationships and information flows are mainly between local suppliers and their customers. With proximity, it is said that the businesses gain flexibility and cost efficiencies through the development of informal supply relationships (Schumpeter, 1934; Ghemawat and Nueno, 2003, Mudambi 2008; Storper and Venables, 2004; Perry and Sohal, 2001; Simmie and Sennet, 1999). As previously described, Porter-type models emphasise how interactivity perpetuates competitiveness between firms, and fosters innovation through an enhanced ability to recognise gaps in the market (Porter, 2000; Duranton and Puga, 2003). These clusters are often linked to institutional and other public goods, with the cluster facilitating the flow of research and educational programmes (Porter, 2000). Key to these models appears to be the proximity between research establishments and specialist businesses, but the mechanism for these spillovers is less understood. More recently Pratt (2013) suggests that the highly risky creative digital clusters particularly benefit from clustering help with the development of economies of scale and the minimisation of investment risk, through the development of industry intermediaries which assist in “deal flow” i.e., the volume of activity, as well as through the circulation of specialised knowledge which helps to balance the risk of investments. In this study, Pratt helpfully proposes that firms benefit from serendipitous rather

than routinised connections which are enhanced in a cluster. Other noted benefits include increased opportunities for technological knowledge exchange (Tödtling, 1992) and general business support (Lafuente et al., 2007; Stam and Spigel, 2016). However, the conclusions tend to be generic and often relate to larger, regional clusters.

Cluster models also exhibit varying intensities of knowledge flows, which cast some aspersions on the centrality of knowledge flows to all cluster models. High intensity of interaction at the local scale has been called "buzz", and is the cause of much academic debate (Bathelt et al., 2004; Maskell et al., 2006; Storper and Venables, 2004). "Buzz" has been the focus of the entrepreneurial literature, where some cities are said to act as "nursery cities", characterised by busy information flows, "buzz" and "noise" (Duranton and Puga, 2001; Storper and Venables, 2004; Bathelt et al., 2004; Grabher, 2007; Nathan and Vandore, 2014). An unresolved debate (which may also have deflected cluster research) relates to the importance of homogenous as opposed to heterogenous linkages (Amin and Thrift, 2002; Nathan and Overman, 2013). The strategic business literature suggests that these dynamic clusters provide nursery facilitation for same-sector innovative stages of the value chain, with later, less innovative stages perhaps moving out of the city to lower-cost peripheral areas or outsourced overseas. (Tödtling, 1992; Davelar and Nijkamp, 1987). However other "buzzing" clusters are seen as optimising the opportunities for "sharing, matching and learning"[5] of information in general (Duranton and Puga, 2003). This might be between heterogenous firms, leading to the possibility of the cross-fertilisation of ideas between specialist sectors (Duranton and Puga, 2003; Sunley et al., 2011), or between firms with "common fortunes, habits, routines and path dependencies of firms within the sector in question" (Boschma and Frenken, 2010: 121), that is, homogenous linkages which might be associated with clusters relating to specialist employment pools and employment-related information (Storper and Venables, 2004), or technological knowledge spillovers (Storper and Venables, 2004: 365; Storper, 2013: 149). Also, one should not overlook the effect of the male gender bias to social relationships, and the potential development of a "Bro" culture which would have an effect on relationships and interactivity (Kerr and Robert-Nicoud, 2020: 63). Ultimately it needs to be recognised that there is relevance in both diversity and specialisation within "buzz" (Lindqvist et al., 2008), depending on the niche working practices and cultures of the firms involved and the characteristics of the locality. It could be that differing amounts of diversification and cluster relatedness are more or less appropriate to different contexts and their

[5] Duranton and Puga (2003) proposed that clusters augment the opportunities for the "sharing, matching and learning" enabled through knowledge exchange. "Sharing" refers to community use of indivisible facilities, including gains from markets, raw materials and distribution networks, "matching" relates to meeting needs with demands (including labour markets) and "learning" is the generation, diffusion and accumulation of knowledge and ideas.

unique industry bases and spaces. The debate remains unresolved, and which is now reflected in the "one size fits all" policy approach to cluster development. There is a lack of attention to the specifics of "place" with overly generic interventions resulting in "clone-like" city centres, instead of celebrating differences between and within cities and encouraging more appropriate nurturing environments for economic development, as was demonstrated by Wagner and Sternberg (2004) in their study of German cities.

The focus on "buzz" and local interactivity may have been a diversion in terms of the development of cluster theory. Some authors have pointed to the potentially equal importance of global connectivity to clusters. The balance between local and global interactivity is likely to vary by industry (Wolfe and Gertler, 2004; Simmie, 2004; Bathelt et al., 2004), and there are several studies which show that local interactivity in clusters is very low key. In a study on the opto-electronics industry, it was found that there were few benefits between business in or out of clusters (Hendry and Brown, 2008). In further studies, low levels of localised interactivity were noted by Isaksen (2004) in terms of the Oslo software cluster, and by Giullani and Bell (2005) in the Chilean wine cluster. In Pratt's study of the book publishing and music clusters in London, the low levels of interactivity were due to their relative lack of competitiveness and a less pressurised need for a skilled workforce (Pratt, 2011). In a later paper, Pratt (2013) develops his ideas on the importance of information flows, suggesting that differing product areas have differing dependencies on information flows, which would lead them to cluster or not. However it may be that other factors are at work. Pratt (2013) noted intense localised interactivity in his study of digital games in London, yet Vallence's (2014) study of the digital games cluster in Newcastle noted a lack of interactivity between the businesses. This, he explained, was due to both the decentralised geographical locational patterns of the industry and their particular working practices, which involved long projects and stable workforces. Notably a further study on a digital games cluster in Manchester (Chapman, 2014) notes low levels of local interactivity between the businesses, which, she says, have no interest in sharing ideas. It seems that they are drawn to the location to take advantage of cheap workspace in the city centre and their proximity to the central train station and fast connections to the capital city, where their publishers are located. In a study on the design industry of London, the businesses also fail to recognise merit in local interactivity, relying on global connectivity (Sunley et al. 2011). In two separate studies on creative clusters in London (Clare, 2013; Foord, 2013), the authors point to the attraction of being part of a community and value the local "buzz" in terms of simple enjoyment and providing a stimulating environment for ideas. (Sunley et al., 2010). It would seem that local "buzz" can simply be a subtle locational driver, rather than important information flows. Finally, business life-cycle stage also seems to have a role to play, with small and medium businesses arguably much

more dependent on external knowledge flows, and supply chain connectivity being critical to their survival (Kelley and Helper, 1997; Mytelka, 1998; Stam, 2010). On the other hand, more mature/larger businesses may close in on themselves and internalise their information flows (Mytelka, 1998).

The literature shows that many clusters may be operating simply as agglomerations, and that other mechanisms, potentially related to supply side factors, may be at play. It is difficult to compare the evidence between differing studies set up in different ways. It is unclear what the differentiating variables are: for example, the quality of the information may have a role to play, as proposed by Sorenson et al. (2018), who said that only moderately complex knowledge is likely to be transferred via face-to-face means. It appears that the jury is out on the importance and mechanics of localised interactivity and knowledge flows as a clustering characteristic. It is clear that information flows are the "glue" in some clusters, (Storper, 2013: 150), but not in others. The reasons for the variability between clusters remain little understood and need exploration.

2.2.4 The micro processes surrounding the dynamism of clusters

A major criticism of the earlier cluster models is the static approach that was taken (Trippl et al., 2015). This has changed since the embracing of evolutionary approaches in economic geography. The approaches have legitimised and encouraged a more granular focus on clusters which has helped to reveal the fact that a cluster is the result of both dynamic internal and external mechanisms and evolutionary processes (Trippl et al., 2015). The approach recognises the temporal elements of business, economies and place, and the idea that a place will include a transient, complex mix of forces and dynamics, including market flows, inter-organisational flows and the dynamism of change. Rather than expecting these flows to be in equilibrium, as previously assumed, evolutionary models recognise their disequilibrium and dynamism (Sunley, 2000).

The evolutionary studies suggest that knowledge flows remain central to cluster models (for example Rooney et al., 2005), the idea being that the more active the knowledge flows and learning processes are, the more flexible and adaptive a cluster will be. Much of the research has focused on cluster evolution which has been related variously to product life cycles (Vernon, 1966; Thompson, 1968; Utterback and Abernathy, 1975) and industry life cycles (Klepper, 1997; 2007). Sölvell (2008) compares the evolutionary stage of differing clusters of IT industries in Stockholm and notes differential clustering dynamics depending on both the sector and the age of the cluster. Work by Malmberg and Maskell (2001) describes the evolution of a cluster in terms of development paths, as a "chain of cumulative causation" (Veblen, 1898; Myrdal, 1957), whereby a

start-up business which is similar or complementary to those that already exist in a locality will be attracted to the locality not only because of economising on locational search costs, but also taking advantage of earlier investments and institutional adjustments. Firms with complementary competences will benefit from the chance of increased local demand or new sources of supply. A similar phenomenon is likely to be occurring at the level of the worker. Employees with specialist competences will be attracted to this industry cluster. Over time some will leave and start their own businesses, inevitably invoking locally learnt working practices and routines. If these working practices adopted by the cluster are particularly competitive and successful, the incumbent businesses have a heightened chance of survival and following rounds of selection and intensified local rivalry (Porter, 1990), stable local clusters are formed including firms that eventually dominate an industry nationally and even globally (Boschma and Wenting, 2007; Buenstorf and Klepper, 2005; Thompson and Klepper, 2005; Klepper, 2002; Dahl et al., 2003; Dahl and Sorenson, 2012; Juhász, 2019). It would appear, however, that a cluster may struggle once firms get set in their routines and development paths. If institutions fail to respond, this leads to "isomorphism", and a potential "lock-in" situation. If the cluster fails to readjust or rejuvenate itself, this can signal terminal decline (Cornwall and Cornwall, 2001). It is said that the solution to cluster sustainability is to retain a culture of openness and flexibility, supporting transformation, rejuvenation or mutation of the cluster (Cooke and de Laurentis, 2010; Hodgeson, 2003; Strambach, 2002 and 2008; Sunley, 2008).

There are many studies which recognise the potential benefits of clusters to entrepreneurs, however very few deal with the clustering benefits of businesses and clusters as they mature. Those that exist suggest varying benefits, to the extent that older businesses may prefer to move out of a cluster to protect market share (Sorenson and Audia, 2000). Maskell and Malmberg (1999) suggest that these businesses are affected differentially due to a mix of reasons, the way their knowledge assets are embedded in the organisation, the geographic boundaries of the cluster and how resistant the businesses are to imitation by rivals in competing locations. It could be that differing industries have differing needs at different times, as proposed by Huggins (2008). It follows that clusters of different sectors may have differing dynamics and outcomes depending on the fortunes, habits, routines and path dependencies of the sector in question. Such ideas could well be tested by a multiple-case-study approach yet such research is thin on the ground. This is a gap which this study can pursue.

Finally, whilst the dynamic nature of clusters is recognised, research relating to the effects of the dynamism of the contextual institutional components, not least perhaps the most volatile of institutions, the land and property market, is extremely rare (Duranton, 2011). This is a major research gap that this study can attend to.

2.2.5 Conclusions, theoretical debates, literature gaps and a way forward

The breadth, bias and complexity of the cluster literature has shed light on a confusing variety and range of potential characteristics and functionalities of clusters. Information flows and interactivity can be important, but it is unclear whether they are the driving force behind co-location or whether there are other external, especially place based factors at play. Layered on top of this is the more recent recognition of the dynamism of clusters, their characteristics and contexts. The benefits of clusters may be more or less important to businesses at differing stages of their development. The understanding of these agglomerations is a "work in progress".

Three generic characteristics of clusters are presented, which help to form the basis of a working definition: co-location, local face-to-face interactivity and dynamism. These characteristics are represented differently in each cluster. The differences are likely to be the result of a brew of nuanced variations between niche sector business working practices, life-cycle stage, and local temporal and spatial contextual characteristics.

Co-location may facilitate connectivity which may be associated with local face-to-face interactivity and the transference of tacit knowledge, albeit that the value of these knowledge flows can vary, as can the intensity of the interactions. The literature is patchy and the evidence poor, but some notable gaps are apparent including understanding the locational decision making processes of clustering firms, the benefits of localised face-to-face interactivity, the benefits of clusters to maturing businesses and, centrally to this study, the effects of external place-based institutions, including local land and property markets. These gaps can usefully direct this study.

The review identifies two major outstanding theoretical debates which can be investigated as part of the study: firstly. the issues surrounding heterogeneous and homogenous interactivity and the function of "buzz" (Section 2.2.3), and secondly, the significance of including life-cycle recognition in cluster research (Klepper, 1997 and 2007; Sölvell, 2008) as first described in Section 2.2.4.

It is clear that the microprocesses associated with clusters remain poorly understood (Storper, 2013: 150). Despite the lack of answers, clusters are complex dynamic adaptive phenomena (Nicolis and Prigogine, 1977, 1989; McKelvey, 1997), often but not always benefiting the incumbent firms, and integral to both local and regional economies (Martin and Sunley, 2007a; Trippl et al., 2015) and worthy of more forensic investigation at the local level. Specifically with reference to this study, if we want to understand the clustering processes of niche sector digital technology clusters in different places in the UK, the literature is unable to help us. More needs to be understood in terms of the significance of technological niche sector business locational decision making, their behaviours and working practices, and secondly how to approach "place" if

a start on its significance to cluster development is to be made. These fields are the focus of literary exploration in Sections 2.3 and 2.4 with a view to helping frame the research and develop a theoretical hypothesis for the study.

2.3 Digital technology clusters

This section explores what is known about digital technology clusters, with the aim of identifying a working definition, drawing out any distinctive characteristics and working practices which may have implications for their locational preferences, and finally recognising where the literature gaps are in order to set a baseline for the study and direct its approach.

2.3.1 Background and a working definition

The early literature on information communications and technology (ICT) clusters tended to be at the regional scale, in line with the perspective of local economic development inquiry (as described in Section 2.2). There was little attempt to explore the granularity of these clusters. High-tech regional clusters lumped technology firms together, representing a region of converging, innovating and path-dependent clusters (Cooke, 2010). Such early cluster studies included Saxenian's (1994) seminal work on Silicon Valley, and UK studies on the computer hardware cluster of the south-west (Cooke, 2008) and the Cambridge ICT cluster (Segal Quince Wicksteed, 1985). The focus of the research, as with other cluster studies of the time (Section 2.2.2), was information flows and knowledge spillovers (Boschma, 2005; Cooke 2008a). Only a very few studies attempted to look at the granularity of sectors: Bottazzi et al. (2002) highlighted how differential cluster development might be due to varying industry supply-chain requirements and divisions of labour, whilst Isakson (2004), studying the software industry of Oslo, recognised the industry's project-based business model and the need for strong relationships with customers and other consultancies. Boja (2011) distinguished between "low value end" or large firm–dominated clusters seeking to reduce supply-chain costs, and "high value end" technology clusters, or close-knit, highly dynamic entrepreneurial communities reliant on specialist labour and knowledge spillovers, which may or may not be clustered around universities (Brown and Duguid, 1991; Amin and Cohendet, 2004; Guerrieri et al., 2001; D'Costa, 2003; Caron and Pouder, 2006; Markasen, 1996; Boja, 2011).

A central reason for the lack of identification of the granularity of these large clusters is the outdatedness of the Standard Industrial Classification Codes (SIC) which are still largely being used for national statistical data collection. Many of the classifications remain broad and unable to pick up niche sectors. To get over this limitation, the UK Tech Nation programme undertook a

comprehensive exercise[6] which identified numerous niche technology sectors, highlighting the fact that some niche sector businesses are clustering whilst others are not (Tech City and Nesta, 2016). The report has usefully guided the identification of niche sector clusters for this study, so its description of a digital cluster, is relevant – that is,

> *a critical mass of digital technology businesses, within an urban location, which interact formally (e.g., by trading or forming partnerships) and informally (e.g., networking, socialising).* (Tech City and Nesta, 2016: 120)

However, in my view this definition needs modifying for this study. The urban location is vague and suggests that more provincial locations are unlikely to provide contexts for successful digital technology clusters, which from their own research is not the case. The differentiation between formal and informal interactivity is unhelpful when both or neither may be relevant, and the dynamic aspects of the clusters are overlooked. Thus, I propose that the working definition of a digital technology cluster should be more aligned to the cluster definition (Section 2.2.1), and for this study should be:

> **A dynamic critical mass of co-located niche sector digital technology businesses exhibiting some degree of heightened levels of localised face-to-face interactivity.**

2.3.2 Do digital technology clusters differ and does niche sector matter?

The reasons for the differential clustering behaviour of digital niche technology sectors are unclear. From the studies that exist, it seems that differing niche sector specific working practices may be partly responsible. For example, Christensen's (2011) study of the cybersecurity industry points to the niche sector's reliance on technical knowledge and skills in an intensely competitive market. In the case of software consultancies in Oslo (Isaksen, 2004), proximity to major clients was key, whereas digital media companies appeared to be drawn to cultural attractions (Kotkin, 2000; Storper and Venables, 2004; Pratt, 2011). However, in his industry-specific study on the digital games and media cluster of San Francisco, Pratt (2009) observed the intense need for knowledge workers and the associated job insecurities. This labour pool idea for digital niche

[6] The Tech Nation programme identified digital tech clusters based on quantitative indicators including the density of digital tech businesses within an area (Source: GrowthIntel), economic performance and growth rates (Source: ONS and other data sources), level of community activity (meetups), together with qualitative insights such as the existence of networks and supporting organisations, presence of a start-up/entrepreneurial community, and participation in the Tech Nation research (Tech City & Nesta 2016).

sector clusters is attractive in that it is likely that the industries have responded to the new digital technologies unevenly, such that they are more or less dependent on scarce technological skills and therefore on the local "pool of labour". Work by Beker and Haswell (2013) showed that there is a spectrum of technological labour needs in the creative industries, with some skills being more scarce than others. Music, film and television industries have been quick to embrace digitisation, and can be found in clusters, whilst publishing and services have been slower to adopt the new technologies, having less need for them. Furthermore, there is a literature which points to the male domination of these tech communities, with their distinctive working practices of long hours and keen attachment to their work, which might be responsible for the spatial segregation of these industries into clusters (Massey 1994, 1995; Kerr and Robert-Nicoud, 2020).

Several authors claim that the processes of complementary convergence and the "platform economy" are directly responsible for the emergence of these digital enclaves or micro-clusters (for example Klepper and Thompson, 2006; Christensen, 2011; Evans and Gawer, 2016). There is also likely to be a life-cycle aspect to these clusters: Christensen's (2011) case study, referred to above, describes how products are initially launched in response to customer demand – and then there is a second, more gradual stage of product convergence or integration, when products mature and market opportunities arise through matching and development of aligned competencies. Christensen says that it is at this second stage of firm development that clustering benefits firms, when commercial opportunities through complementarities are easier to identify and access. However, even the idea of convergence being responsible for clustering is uncertain, with some authors suggesting that technological platforms can both increase and decrease convergence (Yoo et al., 2012; Gambardella and Torrisi, 2014). Kenny and Zysman (2020) describe how platform-based competition is leading to creative destruction and the profound restructuring of industry sectors, as internet conglomerates keep growing in power and influence – an effect which may well increase the divergence between these powerful large firms and small firms and freelancers. There are clearly powerful forces at work which are little understood. Niche sectors and working practices drive differing behaviours and differential convergence results. It is important to ascertain how important these differences are.

2.3.3 How does "place" affect digital clusters?

As with cluster studies in general, the literature has been biased away from interrogating the place-based aspects of clusters (David et al., 1996). A very few studies are interested in the spatial development of digital technology clusters and have started to unravel the implications of the microprocesses of place. For example, Florida (2013) observes how the previous generation of high-tech companies tended to cluster in suburbs of low-rise office parks near the headquarters

operations of the main software companies of Intel, Google, Apple, Facebook and Microsoft, in the technical capitals of the US. Amusingly, Florida critically labels these clusters “nerdistans” and compares Silicon Valley to a “giant parking lot”. His more recent research on Silicon Valley suggests a changing locational pattern, with the large tech offices becoming far more distributed, and small businesses moving towards the city centre. It is not clear what processes are at work here (Florida and Mellander, 2016), but a separate study on migration patterns relating to Silicon Valley suggests that rising rental values have a large part to play (Osman, 2015). The effect of rising rental values is also seen as the initial motivation for digital firms moving to the East End of London. The previously referred to study by Nathan and Vandore (2014), which tracked ICT businesses between 2007–2010 in the east of London, shows how start-ups were initially attracted to the cheap rents of the older premises in a previously creative and semi-industrial area, but that rising rental values and the lack of larger premises were shown to be putting pressure on the growing firms, with some evidence of firms moving into contiguous neighbourhoods of Hackney, the City of London and Camden. The research does not extend to understanding the reason for the shifts, but they are aware of floor plate and size issues, and the rising costs of space and unsurprisingly, suggest that future research should focus more on developing an understanding of company locational behaviours. Similarly, the effects of rising office rents are a problem for the “buzzing” Bristol Temple Quarter (RTPI, 2016). The study, which compared the behaviours of media and digital production companies, recognised that digital niche sectors may react differently to rising rental values.

Alternative research shows that digital business location is not just about rental values. Moeller (2012), in his study on Berlin, also recognised the attractiveness of being near the central, culturally interesting areas of Berlin. Today Berlin boasts a vibrant start-up community of digital businesses, with some 50,000 digital workers. City centres are popular due to their vibrancy and association with culture, especially for today’s digital entrepreneurs, reflecting lifestyle preferences and making global cities such as San Francisco, New York and London especially attractive (Florida, 2012; Katz and Bradley, 2013; Spencer, 2015). As discussed, such centres are also often associated with “buzz” (Section 2.2.3), which seems to have a reinforcing effect on the attractiveness of place for the global digital nomad. It appears to be both the result of co-locating businesses but also something that works to attract them. Once again, the literature is divided as to the purpose or attractiveness of “buzz”. For some it has a functional purpose, where firms need the associated interactivity opportunities to form new relationships and share information (for example Scott 1998; Gordon and McCann, 2000; Pratt, 2000; Storper and Venables, 2004). For others, including Huber’s (2012b) Cambridge study, there is little evidence of relationships and knowledge sharing between ICT workers, the observation being that non-local relationships could

be at least as important. Nathan and Vandore (2014), for example, observed that the local "buzz" associated with London's Tech City revealed weak ties and linkages between businesses; and the local "buzz" associated with the creative industries of New York showed the randomised nature of connections and the important role of events in the local social milieu (Currid and Williams, 2010). More pointedly for this study, Martins (2014), in her study of Tech City in London, recognised how urban design, including density, the availability of public places, streetscape character, the presence of bars and cafés and the vibrancy of the evening economy, support the working practices of the local firms. Specifically, she showed that knowledge spillovers drop off from a distance of 100m to a maximum distance of 400m from the workspace, a distance which is walkable from tech offices and which fits in with the "walkability" ideas in urban design literature (for example Ewing and Handy, 2009). Notably, Martins also recognised that knowledge spillovers were greatest between researchers in related fields, suggesting that an IT-related cluster "buzz" has a more granular composition than assumed in many studies, (for example Nathan and Vandore's (2014) work on the IT cluster of east London, Florida's (2002) work on creative clusters, and even Saxenian (1994) in her seminal study of Silicon Valley). Other researchers think that digital workers simply want to be in the "thick of things" (Nathan and Vandore, 2013). Questions remain unanswered, as to whether knowledge is being circulated, its nature and to what extent is through face-to face interactivity as opposed to virtual transmission (Bathelt and Turi, 2011).

Some cluster-related literature has introduced more intangible locational factors, including the lifestyle preferences of creative businesses (Florida, 2002; Glaeser and Kahn, 2004) and the brand value of place (Nathan et al., 2018). The importance of these factors appears to have increased as the businesses become more mobile and increasingly dependent on scarce, niche talent (Haughton and Amendinger 2008). "Place branding" is a well-known tool for economic development practitioners (Ward, 1998; Markusen and Gadwa, 2010; Klijn, 2012; Zenker and Braun, 2017). It has been used extensively in relation to ICT clusters, including the "Tech City" initiative in East London (Nathan et al. 2019). Equally, workplace branding has entered the realm of business, as they compete for skilled labour in the form of employee value propositions (EVP).[7] In today's competitive job market such management tools are crucial and involve "everything that matters to employees about their work and their organisations, the things they brag about at the neighbourhood barbeque" (Deshpande, 2019: 3). Businesses increasingly wish to align their corporate cultures with their locational strategies, central to which is the idea of projecting an attractive image, often inclusive of a perception of a certain quality of life and working

[7] EVP is the balance of the rewards and benefits that an employee receives in exchange for their performance in the workplace. Organisations generally develop an EVP to provide a consistent platform for employer brand management (Deshpande, 2019).

environment, which is attractive to staff, clients, partners and consumers. Reflecting or reinforcing this trend are the numerous “best place to work” surveys which generally encompass both attractiveness and healthiness indicators of the work environment (Tuuk, 2012). As previously noted (Section 2.2.3) there is also the recognised effects of gender on locational decision making. In male-dominated sectors, including technology, locational decisions are likely to be gendered, which could be an explanation for the clustering of technology businesses (Massey 1994; Kerr and Robert-Nicoud 2020).

Finally, it is notable that much of the evidence related to digital clusters is biased in favour of city centres, which have tended to become synonymous with digital communities. In fact this is not always the case; Hutton (2008) and Foord (2013), for example, describe the existence of city fringe micro-clusters, whilst the Tech Nation Report 2016 shows that tech clusters are to be found in urban centres of varying sizes throughout the UK. Property market research also highlights the move of digital technology firms not only into London, but also Cambridge and Brighton, and other well-linked satellite towns such as Bracknell and Woking (Economist, 2014). It is possible that more provincial centres may support differing microprocesses, something which this study can pursue.

2.3.4 The dynamic complexity of digital clusters

Digital technologies are particularly dynamic and fast changing. The dynamic traits of digital clusters have been picked up in studies relating to path dependency patterns. Simmie and Sennett (1999) showed how the spatial patterns of the emerging information society of south-east England were based on industrial patterns of the past and transport corridors. More recently, the path-dependent processes of digital technology clusters have been described in several studies which have recognised how clusters may morph into new clusters as the related industry develops (Cooke, 2008; Hutton, 2008; Nathan and Vandore, 2014; Pratt, 2013). However, it is also clear that not all digital technology clusters emerge from older clusters. Since the industrial district models of Marshall (1920), there have been many examples of how one or several innovative entrepreneurs could provide the stimulus to generate a new cluster (for example Andersson, 1985; Florida, 2002; Glaeser et al., 2005; Feldman and Francis, 2006; Cooke and Lazzeretti, 2008; Malecki, 2010; Andersson et al., 2011; Guimaraes et al., 2013), and it appears that digital clusters may be no different. Marston et al. (2010) describe how the semiconductor cluster of south-west England started because Fairchild Semiconductors decided to locate their design office in Bristol in 1972. Ironically, the location was chosen on the basis that it was far removed from any competition and they felt they would be better able to retain staff. Coincidently, in 1978, Inmos, the government-backed company and crucial training ground for

engineers, moved into the same area. At about the same time, Swindon lost its railway functions and saw the need to encourage other industries that would employ engineers and provide employment to women. They encouraged Plessey Semiconductors to move to the town, who were attracted by the closeness of Inmos and Fairchild. The cluster was consolidated by the training offered at the Universities of Bath and Bristol, which in turn helped to create serial entrepreneurs within the semi-conductor sector. Thereafter venture capitalists moved in, together with network development and incubation facilities. The regional semi-conductor cluster had arrived.

Cluster life cycles and the cluster's role in business life cycles are likely to be equally relevant to digital clusters. Isakson (2004), in describing the software consulting cluster of Oslo, recognised that it was probably in the early stage of its life cycle. The "new" industry was creating localised externalities, with the consultancies clustering around major clients and software houses. The study did not consider what the next stages of the evolution would be, which could have been a useful step. Other studies are more helpful, highlighting how the stages in a firm's business cycle with their corresponding differing working practices may make locating in a cluster more or less useful (for example Huggins, 2008). It would appear that, on the whole, digital technology clusters benefit entrepreneurs and start-up companies, which are heavily dependent on relational capital and trust with clients and collaborators – components which demand intensive personal interaction (Economist, 2012; Cockayne, 2016). However as with conventional clusters, the benefits of cluster location for maturing businesses are less clear, although the previously cited study on the semi-conductor industry of the south-west of England, Marston et al. (2010) suggests that the more mature businesses had a growing need for outsourced skills, which made location within the cluster important. Clearly the answer about mature industry clustering needs is likely to be complicated. It could be that all these business characteristics have a role to play, compounded by the niche industry effect and the fact that their needs may differ at different times, which could be reflected in the nature and functionality of their respective clusters. One study which stands out as recognising the complexities of not only niche sector but also the life-cycle stage of businesses and attendant working practices is Sölvell's (2015) comprehensive study of ICT clusters in Stockholm, where he maps, identifies and describes niche sectors by neighbourhood and local relationships. The results are a detailed, granular and useful evidence base of the ICT ecosystem of the capital for policy intervention.

As with the cluster literature in general, contextual dynamics have received little attention. The evolving business needs are likely to be reflected in the space and the role of the built environment. The Cambridge study by Segal Quince Wicksteed (1985) recognised the need for a continuum of workspace reflecting business developmental needs, comprising cheap start-up

space, followed by premises of about 400 sq. ft. as companies grew to about 4–5 people. The latter kind of space was mostly provided in the city centre, in old buildings sublet from larger firms. The identified critical issue at the time was to provide for companies at later stages of development, as they identified a dearth of premises ranging from 1000–2500 sq. ft. (Segal Quince Wicksteed, 2000b: 15–16). Having identified the gap, the planners were well placed to guide the building of a number of research parks and support the development of the technology cluster. The study however glossed over niche sector businesses needs thereby failing to develop an understanding of the need for proximity or face-to-face interactivity and knowledge flows. A finer-grained approach might enable developers to plan accordingly.

2.3.5 What are the characteristics of digital industries and how do they affect their spatial preferences?

The above sections point to the limited number of case studies on niche sector digital clusters. In order to furnish this study with some understanding of digital industry locational requirements, this section takes a bottom up approach of isolating recognised characteristics of digital technology businesses and probing their locational implications and ultimately cluster development. These characteristics relate to smaller hardware requirements, low barriers to entry, a strong customer focus, and dependence on very niche technological skills (Towse and Handke, 2013; Morretti, 2013). Each is discussed below.

2.3.5.1 Smaller hardware requirements

On the whole, niche sector digital businesses do not need the physical space nor access to road transport infrastructure required by traditional industries or indeed the previous generation of computer technologies. This has enabled them to take smaller workspaces, and as noticed in the creative industry studies, many digital creative businesses at least are attracted to central city locations (Champion, 2014). In the UK, London has become the location of choice with more than 45,000 high-tech start-ups in the capital in the five years before the third quarter of 2015, 98% of which are small businesses. This trend has been afforded by the smaller workspace footprint requirements, with companies relocating from the traditional home of the high-tech along the western M4 corridor, into London and Reading (Jones Lang LaSalle, 2016).

City centres are offering new forms of working environment, including a variety of flexible working space options. Whether these spaces are the cause or the effect of the attraction to city centres is less clear, but certainly they are a central part of the locational equation. The question can be probed in the study. These communities are increasingly professionally managed with a recognition of the importance of softer infrastructure requirements, which include for meetings,

talks and parties, a need for openness and a sense of community, a sense of activity and increasing the hype, attractiveness and tolerance of failure portrayed by the colony, (Field, 2012; Isenberg, 2010; Payne, 2013). Technology platforms are now central to many new start-up offerings, with events such as “Hackathons” organised to support interaction and networking.

2.3.5.2 Low barriers to entry

The low barriers to entry associated with digital technology businesses mean that entrepreneurial communities have grown quickly. According to the RTPI (2016), two thirds of 18–30 year olds in twenty-seven countries would rather set up their own company than take a conventional job. In Singapore, the Ayer Crescent project now houses 100 start-ups based in the world’s most tightly packed entrepreneurial environmental ecosystem, supported by the Government of Singapore. (The Economist, 2014). Other case studies show how these digital communities tend to base themselves in places where young people want to live, such as Berlin, Boulder, London and Amman (Florida 2012; Spencer 2015).

It is suggested that our urban cores and the entrepreneurial ecosystems serve as “nurseries” for these start-ups and SMEs, (Jacobs, 1969; Duranton and Puga, 2001). Often described as digital ecosystems (Nachira et al., 2002), they are said to support the young businesses’ dependence on relational capital and trust (The Economist, 2012; Cockayne, 2016).

2.3.5.3 Customer focus

Not only are these ecosystems described as supporting SMEs, but they are also said to support a process of customer and process feedback loops (Best, 2014). The literature includes colourful descriptions of the entrepreneurial economies of several cities, highlighting their vibrancy and dynamism. Best (2014), for example, describes a large population of technology-based enterprises in Boston, and how new opportunities for innovation are created and enacted through complex co-adaptive processes over time. He likens the processes to those of Darwin’s “small area” in which a “manufactory of species is active but applied to the emergence, coadaptation and growth of diverse actors” (Darwin, 1859). The process is one of constant feedback loops, with today’s digital start-ups being user driven rather than product driven as was the case in the dot com era. They need to find out what users want, pilot it, measure the user reaction and start again, until they reach “product market fit”. This process is referred to as “customer development” rather than “product development”, and it is related to more traditional industries and depends on close customer relationships. Best does not inquire into the locational implications of these processes or whether they are facilitated by face-to-face interaction, but it could be that central city

locations, close to central city-based customers including the financial services and media sectors , provide the optimal base for these feedback loops.

2.3.5.4 Dependence on very specialist niche skills

The dependence of digital companies on very niche sector skills has been well described in the literature (for example Moretti, 2013). In some cases this dependence is considered to be responsible for the labour market pooling phenomenon (Section 2.2.1), which in turn is a plausible explanation for the emergence of niche sector clusters. In London for example, Jones Lang La Salle (2016) describe the migration of some 47% tech and media firms from the West End to Aldgate, Clerkenwell and Shoreditch on the eastern side. The report describes a "war on talent", and how attractive locations and workspaces are increasingly important as a lure for this talent. The vibrancy of the East End of London seems to be the draw for SMEs and freelancers, whilst central districts such as Bloomsbury are largely the preferred locations for large digital corporations such as Google, who rely on the attraction of nearby cultural amenities (Kotkin, 2000; Storper and Venables, 2004). This effect could also be the result of male dominated locational choices. As previously referred to (Section 2.2.3), these specialist skills tend to be the domain of men (Massey, 1994, 1995; Kerr and Robert-Nicoud, 2020) [8], which may be causing bias in their workplace preferences (Massey, 1994, 1995) and the development of relationships. Overall, we have little idea whether the effect is the same for all niche sectors or places, and correspondingly, whether there is more subtlety to be understood.

2.3.6 Section conclusions

This section has revealed that much of the evidence surrounding digital niche sector clustering behaviour is thin and overly generalist. There are no definitive reasons for the clustering behaviours of digital technology sectors. There are insights to be drawn from delving into the granularity and dynamic nature of the industry, with niche sector business models, life-cycle stage and associated working practices apparently playing a role in clustering behaviours, thereby validating the approach to this study.

The section identifies characteristics of digital technology firms which have clear spatial implications. There is patchy evidence pointing to the driving role of smaller physical space requirements, low barriers to entry, specialist skills requirements and a strong customer focus, but currently it is impossible to draw any broad conclusions as to their relative importance by

[8] UK female representation in the technology sectors was 15% in 2016 (https://www.tpdegrees.com/globalassets/pdfs/research-2016/womeninitscorecard2016.pdf).

cluster. Equally, traditional location drivers have a role to play – such as rental values, labour pooling effects and transportation – yet there are other factors which may be unique to niche digital sectors, including the effects of male dominance in the industry, the attraction of "buzz" and a feeling of being in the "thick of things", and the importance of an association with place. What is clear however, is that that the characteristics of place are likely to be strong drivers of cluster formation, and worthy of more in-depth exploration (Porter, 1990; Swann et al., 1998; Rosenfeld, 2002; Hospers et al., 2008; Sőlvell, 2008; Uyarra and Ramlogan, 2012). The evidence currently remains mixed and is often dependent on the questions and focus of the study rather than taking an open exploratory approach to the research. Finally, we are unable to draw conclusions as to the microprocesses of "place" which may be significant in cluster development, which makes it impossible to develop evidence based interventions. This is a major gap in the literature with ramifications for policy development which this study will address. In preparation, the next section attempts to unwrap the concept of "place" in order to identify its significant elements which will become the basis for setting up the research project.

2.4 Place, the built environment and the property market

This section turns to the question of "place", developing an understanding and definition of the concept, exploring how best to work with the concept and examining what is known about its significance in terms of cluster development generally and digital cluster development in particular.

2.4.1 What do we mean by place and how to deal with it?

Section 2.2.1 argued for the need to develop our understanding of the significance of place in cluster development. How to do this is less straightforward. A central issue is how to identify and measure what we mean by "place". In institutional terms, "place" is generally accepted as being a locality which has developed a "specificity of institutions", and which may share common features across borders leading to "space distinctiveness" (Gertler, 1997; Peck and Theodore, 2007). A central characteristic is its physical distinctiveness, of which the built environment is key (Healey and Nabarro, 1990; Turok 2009). The centrality of the built environment to place is a strong reason for making it the focus of the study, supported by the fact that it is indisputably important for business operations, local economic development and cluster formation (Rodrick et al., 2004; Acemoglu et al., 2005). Additionally, the study of the built environmental aspects of "place" has

practical benefits as it is well understood from an institutional[9] perspective and endowed with advanced and thorough data bases, both spatially and temporally, which overcome the perceived measurement difficulties associated with the investigation of place (Rodríguez-Pose, 2013). These data bases offer an accessible set of variables for study, long recognised in some fields for their effectiveness in guiding local economic development both overseas (for example see Farvacque and McAuslan, 1992) and in the UK (Cheshire and Hilber, 2008; RTPI, 2016).

2.4.2 What do we mean by the built environment?

The next step is to identify, define and develop an understanding of the component parts of the built environment which will help reveal its granularity and identify suitable components for measurement. It seems that the "built environment" is a generally accepted but rarely defined term, relating to human-made, material structures and related institutions. It is often recognised as a manifestation of material culture: Deetz (1996) defined it as "that sector of our physical environment that we modify through culturally determined behaviour". Its elements are buildings, urban furniture, and interior design (Baudrillard, 2006) which are shaped through human management activities in the form of land markets and management, land use planning, architecture, engineering and other related disciplines (Lamprecht, 2016). The land (and property) market was proffered by North (1990) as an institution, with formal rules including land laws, tenure, land registration, taxes, planning laws, and rules for compulsory purchase. Informal rules include the weight that is given to various unwritten agreements, and the expectations and roles of private and public sector trust. Today one would refer to the property market as the institution (Healey, 1990; Needham and Louw, 2006; Arvantidis, 2015), which acts to minimise the uncertainties that abound in land and property transactions (Healey and Nabarro, 1990; Rodrick et al., 2004; Acemoglu et al., 2005). The "rules" of the property market institution are the three land-based mechanisms of the local land use planning system, local business rates and incentives and infrastructure development, each recognised in the property market literature as related effective policy tool levers (Cheshire and Hilber, 2008; RTPI, 2016: 52). The potential significance of these mechanisms is endorsed in many economic development studies, for example, the *Guardian* newspaper published an article on the "slow death of Silicon Roundabout" due to issues associated with planning, infrastructure provision and local taxation (Doctorow, 2014). The World Bank has endorsed the same factors in their work on the competitiveness of cities, with the

[9] The institutional attributes of the property market were well studied in the 1990s (for example Needham & Louw, 2006; Cheshire & Hilber, 2008; RTPI, 2016: 52), recognising its role in minimising the uncertainties that abound in land and property transactions, "which allows urban economic potential to be realised" (Arvantidis, 2015).

highest scoring factors being city image, infrastructure, the availability of land, and fiscal and non-fiscal incentives (Zhu, 2005). The identification of the institution and its dynamic component rules or mechanisms helpfully provides a potential framework for developing the approach to the study. Figure 2.3 below summarises the institutional make-up of the property market.

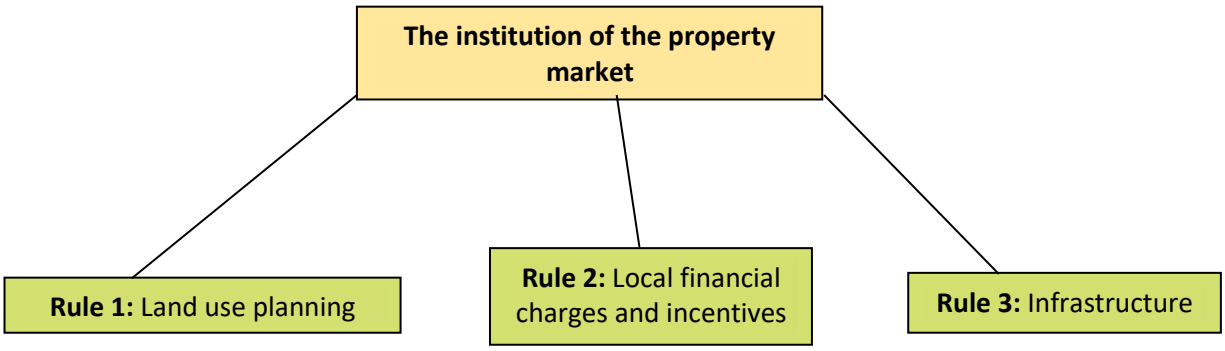


Figure 2.3 The institutional make-up of the property market

The following sections explore what is known about the property market and its component land based mechanism in terms of cluster development, identifies current research debates and gaps in our knowledge, before consolidating the material in an attempt to evaluate how they might affect digital technology clusters and thereafter develop a working hypothesis for the study.

2.4.2.1 The property market

Whilst there were early attempts in the economic geography literature to model the complexities of the property market (for example Park et al., 1925; Berry et al., 1963), more recently, if the property market is included in local economic development studies, it tends to be based on simplistic assumptions relating to demand for workspace simply meeting supply at the right price (Lichfield and Darin-Drabkin, 1980; Healey and Nabarro, 1990). It is proposed that a more detailed understanding is needed to understand the property market's nuanced and localised effects. This type of understanding can be built up from the urban economies literature (for example Needham and Louw, 2006; Arvantidis, 2015), and the city competitiveness literature which emerged in the 1990s (for example Jones Lang Wootton, 1992; Adair et al., 1994, 1997; D'Arcy and Keogh, 1997). From these we learn that demand may not meet the supply of property due to the particular characteristics of the markets, including the impact of investor-centric demand patterns, its cyclical nature and its fragmentation into localised sub-markets and associated information flows. The effects of each are described in the following sections.

Investor-centric demand patterns

The 1990s work on city competitiveness coincided with the development of the institutional approach to both economics and property markets. The view emerged that property values were

a result of institutional and organisational factors, rather than simply demand and supply (Hodgson, 1998a). “Land”, instead of being “stock” and available to the highest bidder as assumed in the old theories of Ricardo, von Thunen and Alonso, was now being seen as a function of complex demand and supply scenarios, relating to three key sub-markets, the “user” market, the “development” market and the “investment” market (Jaffe and Louziotis, 1996; Arvantidis, 2015). These individual markets have different effects on the whole, and the investor market is especially recognised for the way it is likely to skew property development away from the “user” market or tenants’ needs (Edwards, 1990; Guy and Henneberry, 2004). The 1980s saw the trend of commercial properties being viewed as investments, and increasingly they were owned by big organisations such as pension funds whose sole aim was to achieve the best return on the land to support their fund. Their willingness to sell is different to that in a user-driven market, tending towards safe investments, so when an area improves or gentrifies, typically local control over property ownership is lost to larger investment funds (Stanley, 2015). Increasingly, private property development is driven more by investment demand and finance than by final users’ demand and needs, leading to a constant undersupply of appropriate, available accommodation to match the needs of a changing and competitive economy, (Guy and Henneberry 2002). Henneberry and Rowly (1999) recognised that the slow responsiveness of the property market to economic needs was a growing trend which presumably continues today. This insensitivity to demand is likely to be compounded by characteristics of the investment property market, including its domination by a limited number of London-centric risk-averse investors and banks (Gibb et al., 2002), which means that there is less appetite for regional investment activity (Guy and Coaffee, 1999; Guy and Henneberry, 2004).

The cyclical nature of the property market

A further complicating characteristic of the property market is its cyclical operation. Property market cycles have an increasingly integrated relationship with global economic cycles. Whilst the latter typically last over a decade, property market cycles vary in length, averaging about eight years. There are two recognised key property cycles: a physical, tenant-driven cycle of demand and supply which determines vacancy rates, and which in turn drives rental values; and a financial cycle where capital flows based on the investment market are related to the prices of freeholds generally (Investment Property Databank University of Aberdeen, 1994). The markets in both cases are sensitive to flows of information, which are often limited and costly to acquire (Jones Lang Wootton, 1992; Bruhl and Lizieri, 1994; Arvantidis, 2015).

Property market cycles are also differentiated between cities and regions and by property sector (Leitner, 1994). Leitner undertook a study of the office market in a number of US cities between

the early 1960s and the mid-1980s, and highlighted how they showed varying degrees of activity and non-activity relative to national trends. He suggested that the reasons for the differences are location and local variations between cities. The individual, immobile built environmental characteristics of differing places are responsible for generating varied property markets and cycles, generating a limited supply, and a tendency towards rising prices (Evans, 2008).

Localised sub-markets and information flows

The above characteristics mean that property markets differ both geographically and temporally, and for many reasons are likely to be unresponsive to the demand for space – generating price and rental differentials which dictate possible future land uses (Scott, 2011). The property market of a locality will have unique characteristics based on sociological, informational, psychological, macroeconomic and political factors (Sweeney, 1993, Adair et al., 1994, 1997; D'Arcy et al., 1997; Lizieri, 1997). Indeed, the property markets associated with clusters are likely to have market characteristics due to the special augmented demand caused by the clustering forces themselves (Evans, 2008). These sub-markets are often the result of local socioeconomic demand factors that rely on transactional information, which if flowing effectively will affect the ability of a "market institution to adapt its structure and to provide the outcomes that the economy requires" (Arvantidis, 2015). A non-responsive property market is often said to reflect a "market gap" (Jones, 1996; Evans, 2004), and can be due to a deficit or negative impact of any of the above factors. The process of choosing a location for firms is a direct result of property market information flows, something as described in Section 2.2.3, which a cluster may be very good at. The function of a cluster in terms of circulating property market information flows was recognised early on in the classic Industrial District studies (for example Marshall, 1890), but has been largely overlooked in the more recent literature. The importance of property market information flows and the idea that places have differing "property market efficiencies" is a hotly debated topic (Gau, 1987; Evans, 1995), however it is worthy of consideration in this study.

Finally, whilst this section has focused on the supply of commercial property, the residential property market should not be overlooked, not least because it will also have a direct effect on the employment and skills catchment potential of any cluster, as highlighted in the Cambridge ICT cluster study (Segal Quince Wicksteed, 1985). The residential property market has its own characteristics and its own cycles. House prices and availability are directly affected by supply constraints and are extremely volatile. Existing homeowners are to some extent protected from price fluctuations as they are operating within the same market; the problem arises for first-time buyers and people trying to move into a new more expensive area (Hilber and Vermeulen, 2013). The issue has been picked up in some research, e.g., in Silicon Valley where companies are

resorting to bussing employees in (Malezi, 2014) and issues associated with the Temple Quarter in Bristol (RTPI, 2016). The housing market has its own complexities affecting supply and price which the study should be alert to.

2.4.2.2 The planning system

The role of the UK planning system is to ensure the equitable provision or protection of land-related public goods such as open spaces and housing, thereby also reducing uncertainty in the development process and the property market (Mayo and Sheppard, 2001). There is a national economic developmental objective is to provide a flexible, responsive framework to support a healthy, clustering local economy[10], yet there are many obstacles to achieving this. For example, there is no longer a regional layer of administration, which had a useful overview of regional economies, rather the Local Government Act 2000 makes local authorities in the UK responsible for most services including the economic, social and environmental wellbeing of their areas. They organise and manage services including schools, infrastructure, planning, the development of the local economy and the collection of local taxes. In addition, the UK regulatory framework, as contained in the Localism Act 2011, specifically attempted to strengthen local powers regarding economic development planning and business rate discounts. Land-related mechanisms are very much in the hands of local authorities. Specifically, as described in Chapter 1, paragraph 83 of the National Planning Policy Framework (NPPF), requires planning policies to make provision for clusters and high technology industries, addressing their locational requirements, (Department of Communities and Local Government 2019: 23). There is little guidance for planning officers, nor researched understanding of the locational needs of high technology businesses.

The planning system is strongly biased towards housing, rather than employment-led development. A current contentious mechanism which is affecting the provision of business space, is permitted development regulations which allow for the change of use of business spaces into residential unts without the need for planning permission, but not the other way around. From 2014–2017, over ten thousand business units were lost in England through this mechanism (RICS, 2018). The only possibility of reversing these rights is through implementation of Article 4 Directions[11] by local authorities.

[10] As set out in HM Government (2017). Industrial Strategy: Building a Britain fir for the future.
[11] In 2016 an amendment was made to the General Permitted Development Order (GPDO) 1995, allowing the change of use without planning permission from office and light industrial uses to residential uses. This is a national order which can be overturned locally through the implementation of an Article 4 direction under the provisions of Article 4 of the same order.

A further characteristic of the UK system is its “plan-led” approach (as required under the Planning and Compulsory Purchase Act 2004). This means that policy is increasingly taking the zoning plan and delivery target approach. This gives little flexibility or sensitivity towards niche local businesses or creative places and can lead to clone-like economies (Hall, 2003; Sims et al., 2004; Allmendinger, 2006).

Land use planning is intimately involved with the supply of property. Several studies have shown how planning regulations and policies restrict the supply of space, directly raising rental levels and costs (Cheshire and Hilber, 2008; Osman, 2015). Yet the impact of the planning system on business space, and specifically the supply of business space, remains debatable. It is something the UK government has struggled with for some years, instigating several studies on the subject – all of which point to its restrictive effects and inflationary effects (Hall et al., 1973; Gilg, 2005). The Barker Review of Land Use Planning-Interim Report (2006) usefully focused on the role of planning on cluster formation and recognises both positive attributes as well as negative ones. For example, the financial district of the City of London has been supported through effective planning policy support, the maintenance of public space and maintaining a close watch on the availability of workspace. In the case of the high-tech clusters of Cambridge and Oxford, it is noted that their expansion has been limited due to the constraining nature of planning policies, especially the Green Belt, to development on the perimeter of the cities.

Restrictive UK planning policies, in the UK has been much criticised for stifling property markets and economic growth. Contentious work by Cheshire et al. (2012) reiterated the problem, developing an indicator for “planning restrictiveness”, and describing the effect as a “tax” on office development that varies from around 250% of development costs in Birmingham to 400–800% in London. They compare these figures with New York at 0–50%, Amsterdam at 200% and central Paris at 300%. The green belt has also been blamed for the restricted growth of the UK’s second cities, leading them to become functionally too small to perform well economically (Cheshire et al., 2014). However, as Barker (2006) observes, green belts also serve to protect the amenity value of land (see for example Hurdle, 2017), which adds to the attractiveness of place and serves to attract and retain with high-tech workers.

There is a paucity of evidence of the direct effect of planning policy on cluster development. This was recognised as being part of the problem with the previously described high-tech cluster in Cambridge (Segal Quince Wicksteed, 1985). Land use types continue to be separated by the rigid employment of the Use Classes Order (1987) and its subsequent amendments, including the separation of industry and business uses from residential areas. This was an issue in Cambridge, resulting in the building of isolated research parks, with housing being sent out to villages beyond

the green belt, which caused traffic and congestion problems. Furthermore, planners sought to restrict the amount of built space in the research parks, thereby pushing up rents (Segal Quince Wicksteed, 1985, 2000a). Another example relates to the use of special planning zones, for example business improvement districts and enterprise zones, which introduce a light touch planning policy as a mechanism to stimulate regeneration. Hackney Borough Council, through a simplified planning zone, have implemented a "light touch" planning approach intended to support the creative digital sector of Tech City. Unfortunately, it is not clear that the outcome has been as intended (Doctorow, 2014) with rising rents forcing small start-ups out of the area (Jones, 2015).

The plan-led system means that planning policies can vary between local authorities, which can result in a differential effect on the supply and approach to local economies, and specifically business premises and employment-related land. The impact is not well studied in the UK, but Osman's (2015) work on Silicon Valley highlighted the problem as a key factor in the relocation of technology companies in Silicon Valley. This could be one of the drawbacks of setting planning policy at the local authority scale: a potential issue when clusters span local authority boundaries and operate at larger, perhaps regional or metropolitan scales (Lovering, 2001; Haughton and Allmendinger, 2008)**.** Multi-area agreements between local authorities are a potential tool to get over the problem in the UK, where planners are rewarded for working across boundaries. It would be interesting to see if a similar arrangement could be useful for cluster development strategies (Hildreth and Bailey, 2013).

Finally, the literature has picked up on the often slow pace of change of planning polices compared to economic needs. Needham and Louw (2006) described how planning polices relating to industrial estates in the Netherlands had not changed for fifty years despite mounting pressure and criticism. They describe a self-reinforcing type of path dependency which works itself into a circular lock-in situation. A study of the UK planning system might offer similar observations.

In conclusion, it appears that planning policy is likely to have major implications for digital cluster development, but the effects have been understudied. Planning policy directly affects property markets and the supply of workspace. Pro-growth local authorities can, as Barker points out, "be instrumental in ensuring their growth and continue success, as the City of London illustrates". (Barker, 2006: 136). Conversely, planning policies may impede growth as was the case in Cambridge (Segal Quince Wicksteed 1985, 2001a).

2.4.2.3 Local business charges and incentives

Business rates and incentives have been shown to have a direct impact on the health of a local economy (Pike et al., 2006: 16–17; Sommer and Kuznetsova, 2011; Cheshire et al., 2011; Larkin et al., 2011). However, they are not straightforward as they may have the effect of distorting land markets. Business rates can add on average 40% to the cost of renting a commercial property (Evans, 2004; Property Industry Alliance, 2015). Whilst some local authorities view business rates as a funding pool, more pro-business authorities apply them more discriminately, taking the opportunity where appropriate to provide relief or incentives to business development. Until 1990 business rates in the UK were set by local authorities and then subsequently have been set nationally, albeit collected locally and then redistributed nationally. There has been much criticism of the system, including from the Barker Review of Land Use Planning (2006) and the Lyons Enquiry (2012) into local government, which highlighted the resultant disincentivising effect and possible negative impact on the health of the local economy, especially in more deprived areas which are unable to set lower rates. To encourage local authorities to increase business floor space, the Business Rate Retention Scheme has been implemented. Local authorities now retain a portion of local business rates. This is closely monitored by the national government who are responsible for redistributing the rates and for some local discounts. The remainder is redistributed nationally according to local authority success in encouraging the development of rateable business space. There was a good deal of scrutiny into the idea before it was introduced in April 2015 and the jury is still out on the impact.

To date, business incentives or subsidies have often been part of national or European-funded schemes, applied to floundering areas that need some economic stimulation, and included within a larger bundle of mechanisms in a “bottom-up” approach. For example, the Economy and Enterprise Strategy of Calderdale promoted the creative, digital, retail and tourism/leisure sectors with a £2.8 million fund for small projects (Travers, 2012). However, it is not evident that such an approach has been used specifically as part of an existing cluster development strategy, but rather to initiate cluster growth as part of a regeneration strategy. Citing the case of South Carolina and its textiles cluster, Woodeward (2012) is highly critical of the use of financial incentives, which he says are a secondary location decision and tend to compensate for weaknesses in agglomeration economies. Thus it is not clear as to the effect of areal business charges and financial incentives on cluster development. They remain a tool in the economic development tool kit and should be considered in the set-up of this study.

2.4.2.4 Infrastructure

The problem with assessing the role of infrastructure is the lack of clarity over what is meant by the term. Therefore it is useful to distinguish between “hardware”, “software” and “orgware”, (Vázquez-Barquero, 1999). “Hardware” includes the provision of basic infrastructure that is transport and communication networks, industrial spaces and the infrastructure of human capital including education, health and cultural facilities; “software” refers to the design of local development strategies; whilst “orgware” is the “improvement of the organisational and institutional capacity to design, implement and monitor the development strategy” (Pike et al., 2006: 17–19).

“Hardware” infrastructure improvement encourages linkages and connectivity in local economic development and clusters specifically. Haughton and Allmendinger (2008) say it is the key ingredient to cluster development, whilst Doel et al. (2014) argue that a maturing cluster, one which starts to look outwards, increasingly engages with international scientists and overseas partners, which has direct implications for infrastructure provision. As previously described (Section 2.2.2), Simmie et al. (2002) recognised the significance of Heathrow airport for innovative trading clusters, for which exogenous linkages were more important than endogenous connectivity. Champion’s 2014 study of the games cluster of central Manchester showed that easy access to the mainline train station, and thence London, was a central factor in the cluster’s kdevelopment. Additionally, local authorities are keen to cooperate with universities and to facilitate linkages between research and businesses (Echenique et al., 2003).

The provision of business space also fits under the category of “hardware” infrastructure provision. Its provision by the private sector has been discussed (Section 2.3), but it is worth noting that many UK local authorities supply and manage business spaces and see this as an important part of their role, especially regarding the provision of low rental and affordable space. The Audit Commission questioned this role back in 2001, and was critical of the approach, saying that as managers, local authorities rarely reviewed the needs of the business and that there needed to be more transparency of rental income and expenditure (Beacon Council Research, 2001). Despite this review, the Local Government Association continued to encourage local authorities to get involved with incubator or managed workshop space (Local Government Association, 2007). The City of London has been particularly proactive in ensuring the availability of workspace to support the financial cluster (Ramidus 2013).

Science and business parks have been traditionally part of the portfolio of business space and key to cluster development (Segal Quince Wicksteed, 1985; Katz and Wagner, 2014). Science parks continue to be developed, despite indications that today’s creative and digital business may

prefer urbanised and buzzing spaces, something which this study is able to investigate. Recent innovations in workspace provision include flexible workspaces, which is an all-encompassing term for workspace offered on both spatial and legal flexible terms (see Section 4.1). A typology of such new spaces has been established in the literature, including serviced offices, co-working space, incubators, accelerators, industrial estates and science parks – with many being proffered as cluster interventions (Madaleno et al., 2018).

Using Vázquez-Barqero's (1999) framework, "software" and "orgware" infrastructure would include economic or cluster development strategies including private/public sector partnerships. Such approaches are often combined with a "hardware" infrastructure project. A combined approach is often taken where a special effort is being made to invigorate a local economy, such as in the case of the previously described Temple Quarter Project in Bristol (Section 2.3.3). The project was based on an enterprise zone – essentially a planning tool which provides not only simplified planning rules, but also offers tax breaks, business rate rebates and other incentives, together with superfast broadband and some other significant infrastructure improvements (RTPI, 2016). Notably, Pike et al. (2006) are critical of the "scattergun" approach of these combined interventions, because of their lack of regard for local circumstances. Often there has been little or no opportunity for local input or moulding of generic policies to local circumstances, when the interventions are led by regional, national or European funding sources. They are often criticised for being "place blind" (Nathan and Overman, 2013).

2.4.3 How might the property market and associated mechanisms affect cluster development?

In view of the lack of evidence, the next step is to consolidate what is known about the significance of the built environment and its component mechanisms on digital cluster development and then to evaluate how they might be expected their anticipated impact, in order to develop a working hypothesis for the study. Table 2. 2 below, synthesises the literary evidence and provides the summary evaluation.

	Key players	Key areas of impact	Evaluation of likely impact
Property market	Landlords, business tenants, agents	• Place preferences • Affordable workspace availability • Property market information flows	Likely strong impact
Land use planning	Local authority	• Place-making policies, Implications for the preferences of place, e.g., conservation policies, cultural amenities or green space • The market and availability of affordable workspaces through amount of involvement in monitoring and policy interventions	Likely strong impact
Place-based financial interventions	Local authority	• Will have a positive or negative effect on the financial attractiveness of workspace	Likely weak impact. Value appears to be limited as low rates seen as secondary to the merits of cluster location
Infrastructure	Public and private organisations	• Transport communications can be a location driver, e.g., train stations, airport, availability of car parking and motorway access • Workspace provision. Evidence of availability of affordable niche workspaces, science parks and flexible working spaces • Local economic development policies	Likely mixed impact, depending on the sector

Table 2.2 Evaluation of built environmental mechanisms on the development of clusters

From the above table, two components of the built environmental stand out as being likely to have the strongest impacts on digital technology cluster development, firstly the availability of affordable workspaces in preferred locations, including those with good transportation connectivity and are implicated by property market trends, land use planning and local economic development policies. Secondly, the flows of property market information are important in terms of both the private sector and local authority monitoring and policy interventions. These two components and their potential impacts are developed in the following sections, with a view to developing a working model and hypothesis for the study.

The availability of preferred affordable workspaces

The discussion has highlighted how niche technology businesses may have pronounced workspace preferences (Section 2.3.5.4). The workspace preferences may relate both to price differentials and to more qualitative attributes (Malizia, 2014) including finishes, infrastructure provision, tenure type, lease flexibility etc. (Harvey, 1985, 2003; Rodrick et al., 2004; Acemoglu et al., 2005). Rental levels and tenure type may be important for some niche sectors, whilst qualitative attributes may be the issue for others (Malizia, 2014). Furthermore, it follows that an evolving cluster could have to provide for differing workspace preferences at differing stages in its development and growth. This was the case as shown in two previously cited studies, the IT cluster of the East End of London (Nathan and Vandore, 2014), and the RTPI report (2016) for the Bristol Temple Quarter (section 2.3.3) as well for as other start-up hubs. The latter observe the start of a segregation of the clusters of media and digital production companies because of the lack of affordable offices, intimating that this is an unwelcome stage of cluster development. Interestingly, and probably by way of a competitive reaction to the "flight" to the city, there is a very recent trend of upgrading traditional business parks to increase their amenity and "fun" levels with the idea of diverting some of the city bound technology companies (Savills, 2012; Creasey, 2016).

The business cycle appears also to be of significance with regard to location. We know that many start-up businesses generally tend to prefer to stay close to home or near their parent company where there are known networks, and there is the possibility of working part time at least during the initial stages of business growth. These may not be optimal locations and would be affected by local institutional structures laid down in the past (Stam, 2010). Being at the beginning of the business cycle, their development and any potential ensuing clustering is much affected by local variations and path dependency in the local industry structure (Brenner and Fornahl, 2008), institutions (Casper, 2007) and culture (Saxenian, 1994). This, as previously described, is the reason for the very uneven processes of development that continued to persist over time (Martin and Sunley, 2010). Whether this typical pattern of the start-up company still exists for today's digital entrepreneur is unclear, with co-working spaces and incubators becoming commonplace in most cities of the UK and perhaps attracting entrepreneurs away from their local communities (Duranton and Puga, 2001) or the more sterile environments of science parks (Storper and Venables, 2004). Surprisingly, perhaps, we remain unsure. Work by Rosenthal and Strange (2004) is inconclusive on similar issues, whilst a study by Glaeser (2011) finds weakly correlated links between the density of a city and levels of innovation and economic growth. The availability and low rental levels are often proffered as a reason for the initiation of a digital cluster (Section 2.3.3). Pratt (2000), for example, recognised that the new media cluster of New York was in part

about the availability of relatively cheap loft space for developers to live and work in, whilst cheap central workspace was the attraction for the Berlin creative community (Moeller, 2012). However, these studies do not probe any further. Many questions remain, Is loft space of particular use to this niche sector? Is there a gender bias in respect of the locational decisions? What does "relatively cheap" mean? Is relative cheapness a driving factor or are there other locational drivers which are of more importance? We are aware from regeneration studies that communities of creative individuals and industries are attracted by the lower rents associated with obsolescent inner city landscapes, known as the rent gap (Hackworth and Smith, 2001), and are major agents in the regeneration of these areas (Hutton, 2008: 33). However, these communities are recognised as being unstable in the long term, as higher bidding companies move in in the classic formulation of urban transition and succession (Bridge, 2001). This transitional dynamic has not been investigated specifically with regard to clusters and the fact that small clusters are often associated with certain districts (e.g., Soho and advertising or the City of London with financial securities), which suggests that there is something else going on other than simply cheap rental levels. Insufficient detail is provided which is unhelpful for policymakers. Property markets and niche sector working practices are important and should be the subject of focused study. For example, the UK has some of the most expensive office space in the world (Cheshire and Sheppard, 2005), second only to New York (Knight Frank, 2015), yet it is also the number one start-up capital in the world (Florida, 2013). We don't know how the two scenarios coexist, but a comparison of business premises rental values between start-up ecosystems around the world would shed some light on what is going on. Specifically, it is not clear how the raised rental values of agglomerations affect locational decisions. One idea is that the higher costs make businesses hungrier for success (Pinch et al., 2003).

Even less is known about the spatial needs of medium sized businesses and maturing clusters. We are told that maturing firms start to need good infrastructure to develop their international linkages (Doel et al., 2014). However, we are also aware that, as the clustering of firms' increases, this causes a corresponding increase of pressure on the supply of premises, resulting in rising property prices and congestion (for example Combes et al., 2005). As previously suggested (Section 2.4.3), it could it be that the lifetime expectancy of the cluster is simply limited by the lack of premises of the appropriate quality and price, as the cluster evolves. This effect has been demonstrated in several previously referred to case studies such as Nathan and Vandore (2014) and Osman (2015), and is apparently occurring in East London, as Caird (2016) described in her article in the Guardian newspaper. Interestingly, the GftFK Tech City Futures report (2015), which specifically looked at the needs of the East London digital sector, failed to pick up on the property

angle, suggesting that growth issues are related only to lack of skills, access to finance and marketing and promotion. But perhaps the question was not asked.

We are also unsure whether these maturing firms prefer to stay in the cluster or whether other locational criteria start to come into play. Malizia (2014) compared office tenant locational preferences and the performance of office space in three locations, city centres, suburban and other vibrant centres and found that overall, they showed no locational preference, yet they did have strong preferences with regard to quality, cost, building features, access, and proximity to clients and or skilled labour. They also had a preference for vibrant live/work spaces in attractive city settings and specifically old-style campuses were found to be less attractive. However, the study did not single out digital or clustering companies, so we are none the wiser as regards any locational preference for being "in" or "out" of a cluster, or whether digital firms have particular built environmental needs.

In summary, we are aware of the potential for the nuanced workspace preferences of niche digital technology businesses in both space and time, with clear ramifications for the development pathways of a cluster. Little is known about this dynamic interaction of forces and provides a major opportunity for this study.

Property market information flows

As described above, central to the property market are property market information flows, which provide the businesses with knowledge of the market and workspace availability. They are likely to be key to business location decisions, and may be generated through agents, online sources and local business interactivity. The centrality of local information flows to the cluster concept was at the heart of some of the early classic cluster models (Veblen, 1898; Myrdal, 1957), and resurrected in Malmberg and Maskell's (2010) model of the "chain of cumulative causation" of cluster development, and the "locale" model (Guy and Henneberry, 2000; Vinodrai, 2006), a place inclusive of its knowledge resources. The cohesiveness and connectedness of place was also an idea that ran through the city competitiveness literature of the early 2000s, the idea that social cohesion in particular is an important part of local economic competitiveness (Turok, 2003), whilst the property market literature specifically picked up on the link between social cohesion and circulating property market information flows as a feature of city competitiveness (Boddy, 1999, 2003). The idea of locally circulating property market information adds a level of refinement to the recognition of the central role of the property market in the adaptive urban efficiencies of urban development (D'Arcy and Keogh, 1997), which has hitherto been applied at regional and global city spatial levels (Gibb et al., 2002; Jones Lang LaSalle City Momentum Index, 2019), but not at the local level. Competitiveness for space is a central characteristic of clusters, and it

follows that circulating property market information through face-to-face interactivity is likely to be central to local property market efficiencies. Local property market efficiencies and responsiveness, enhanced through clustering, would be an interesting and novel avenue of exploration for this study.

2.4.4 A built environmental model of digital cluster development

A causality model of digital cluster development is proposed in figure 2.4, based on the identified significant components of the built environment. The likely attractiveness of appropriate workspaces to niche sector businesses as part of their images (Section 2.3.3) might feed into their locational decisions which, together with enhanced local interactivity, could be responsible for clusters and also identifiable and reinforceable "islands of development" (Guy and Coaffee, 1999) of the preferred built form associated with niche sector.

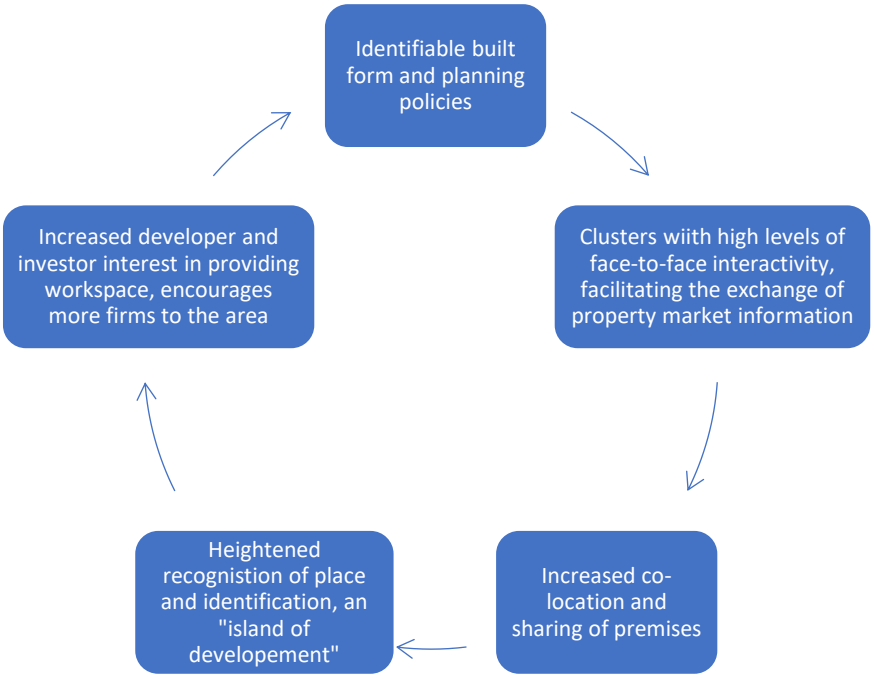


Figure 2.4 A built environmental–based model depicting the circle of causation of cluster development

This model would fit in with the city competitiveness literature and with the idea that cohesion is central to the competitiveness and the attractiveness of city based business location (for example, D'Arcy and Keogh, 1999; Boddy and Parkinson, 2004). As Simmie (2004) found in his study on innovation clusters and competitive cities in the UK and Europe, the most successful cities have specialisms and clusters and are well endowed with finance, social and intellectual capital. Other studies highlight how social cohesion makes for city success. It follows that well-connected clusters play a major part in this. The above model suggests the causative mechanism for city cohesion, clusters, increased competitiveness and ultimately a healthy economy. It is proposed

that an exploratory study of the significance of the bult environment in digital clusters could be the context for validating this model.

2.5 Synthesis of the literature review, the research gaps and confirmation of the hypothesis and development of the research questions

The literature review presents a contextual summary of clusters and cluster theory, and how it has generally failed to investigate the microprocesses relating to localised clusters, having tracked down research avenues relating to interactivity and knowledge flows particularly at the regional scale. Through the economic evolutionary geography literature, attention has been drawn to our lack of understanding of the complexity of the local economic environments (Jacobs, 1969; Powell et al., 2005). We recognise that strong contextual forces are at work, but we know little about the granularity and microprocesses that are at work. The need for a more balanced approach to cluster research is recognised, one which includes both the microprocesses of business development and those associated with the idiosyncrasies of place (Porter, 1998; David et al., 1998; McCann and Sheppard, 2003; Nathan and Vandore, 2014).

Digital industries have created new dynamics with the built environment which are likely to be borne out in niche sector cluster development. These characteristics need more in-depth exploration if we are to develop workable policy interventions. The day for taking a generic approach to digital technology clusters and their contexts, and "tarring them with the same brush" by assuming comparable characteristics (for example Boja, 2011; Kerr and Kominers, 2012), is clearly over, and more primary research is needed to investigate what is going on in respect of this very local interplay of forces. This provides the main opportunity for this study. The next section summarises the identified research gaps in preparation for setting out a way forward for the study.

2.5.1 The research gaps and unresolved debates in the literature?

The literature shows that local property markets, business locational strategy and local economic performance are intimately related (Turok, 1992; Leitner, 1994; Van de Krabben and Boekema, 1994; Ball and Wood, 1996*;* Carlino and Hunt, 2007). We see how the three main cluster characteristics of co-location, local face-to-face interactivity and dynamism could be responsible for a raft of differential cluster characteristics, potentially interwoven with subtle effects emanating from the local built context. We are unclear how these characteristics relate to digital technology businesses which as the review has identified have some specifically implicating

mechanisms relating to their locational decisions, their pronounced workspace preferences, local workspace supply dynamics and property market information flows. This is the central research gap which this study seeks to fill.

There are additionally many other gaps in our knowledge which the study can attend to. The discussion shows that whilst we recognise the differential effects by sector (for example Huggins, 2008; Faggio et al., 2013) and the differences in working practices driven by differing niche sector business models and business life-cycle stages (Perroux, 1955; Porter, 1990), we are unable to recognise which niche sectors might cluster and which may not. We also know that there is likely to be a developmental aspect to clusters, that for example digital start-up companies and entrepreneurs enjoy locating in ecosystems (for example Fothergill and Gudgin, 1982; Jacobs, 1992: 187–199; Comello and Piol, 2013), but this literature fails to discriminate between niche sector industries and their respective behaviours, so it is difficult to apply this to clusters. Additionally, we are aware of some of the dynamics within the ecosystems, but know little about the impact of churning, growing and relocating companies. Specifically, there are major gaps in our understanding on the differential effects of aspects of place on co-location. For example, what are the preferred built environmental aspects of place for digital technology clusters and is this related to the working practices of the incumbent businesses, or are there other factors which are at play in their locational decisions? We recognise that technology clusters appear to occur in a variety of urban settings, both city and provincial centres (Malizia, 2014; Katz and Bradley, 2013), and it would be useful to isolate the factors that have been at play in order to support cluster development interventions. It is noticeable that new forms of workspace ae often associated with city centres (Section 2.3.3), but is the workspace the cause or the effect of niche sector co-location?

Whilst the cluster theory has been overtly demand led in terms of understanding the locational decisions of technology businesses in clusters, there have been recent examples of cluster-related studies which have picked up on facets of the built form and how this feeds into co-location, for example, transportation (Champion, 2014); the availability of flexible working spaces (for example Moriset, 2013; Merkel, 2015; Capdevila, 2014; and Madaleno et al., 2018) which include incubators and accelerators. [12]Most studies relate creative clusters and the urban gentrification phenomenon (for example Ferm, 2016). However these studies have focused on single aspects of

[12] Both provide start-up space for new businesses. Accelerators are based on a competitive entry system and provide intensive short-term support and investment. Incubators are non-competitive longer-term rental spaces, with some business support (Hathaway, 2016).

the built environment. There is a lack of research which has looked at the significance of the built environment as a whole.

Local face-to-face interactivity is a recognised characteristic of clusters, yet we know little about its relative importance to digital niche sector businesses (Section 2.3.5), or the mechanisms behind it (Storper, 2013), and whether being "in the thick of things" is a locational driver for these businesses. Studies variously point to the attractiveness of buzzing neighbourhoods, but we are unsure of either the processes involved or their merits for technology clusters. Do the neighbourhoods provide valuable knowledge networks (Stam, 2010), do they serve as incubating environments (Storper and Venables, 2004), or are digital professionals simply attracted to these vibrant neighbourhoods? Furthermore, despite there being a huge literature on knowledge flows in urban agglomerations, evidence relating to the effects of the built environment has been scant since Jane Jacobs first drew attention to the role of density and small city blocks (Jacobs, 1992). At the same time, this investigation can attend to a series of further research gaps, including developing a more granular understanding of local "buzz", the preferences for homogenous as opposed to heterogenous local linkages, and the role of flexible and collaborative workspaces and events.

Not only do these questions remain unanswered, but they are also part of a wider debate on the importance of city diversity as opposed to city specialism and strong clusters (for example Storper, 2013: 92–103). It could be that clustering has a central role in the urban agglomeration process, so that understanding the clustering microprocesses at the heart of city agglomerations could usefully add to this debate. At the same time the study can attend to the effects of built-environmental differences between provincial and metropolitan clusters which have been overlooked in the literature. Finally, the idea of the causative effect of circulating property market information flows on co-location is interesting and has not been tested in respect of digital technology clusters.

Major research gaps relate to developing an understanding of the dynamics of clusters and whether there is an association with place-related microprocesses. Most cluster studies have taken a static approach, so little is known about the mechanisms associated with cluster evolution, or the significance of the cluster to businesses, particularly as they mature beyond the start-up phase. We are told that such firms start to need good infrastructure to develop their international linkages (Doel et al., 2014), but is this the case for digital industries, and how do transportation needs vary by niche sector? We are also aware that these firms are likely to be expanding, but what will be the effect on the cluster if appropriate workspace does not exist? Are firms likely to relocate or will we see a reorganisation of workspace and corresponding rise in

rental values to meet the needs of business, as described by Combes et al. (2018)? Could it be that the lifetime expectancy of the cluster is simply limited by the lack of premises of the appropriate quality and price as the cluster evolves? This effect has been demonstrated in several previously-referred-to case studies, including those of Nathan and Vandore (2014) and Osman (2015), and it is apparently occurring in East London as Caird (2016) described in the aforementioned article in the *Guardian* newspaper. Yet, conversely, the GftFK Tech City Futures Report (2015), which specifically looked at the needs of the East London digital sector, failed to pick up on the property angle, suggesting that growth issues related only to lack of skills, access to finance and marketing and promotion. The property market is clearly a crucial force which needs to be better understood within cluster development theory (Indergaard et al., 2012; Nathan and Overman, 2013; Saccio et al., 2013).

Overall, the focus of cluster research has often been overly broad, and has overlooked the potential significance of place, the built environment and the property market in cluster development generally and specifically in respect of digital technology clusters. As shown, there are major research gaps relating to the complexities of the local built environment and associated property market, and also a potential recursive relationship between business locational preferences driven by working practices and the characteristics of the local built environment (Porter, 1990; Swann et al., 1998; Rosenfeld, 2002; Sőlvell, 2008; Hospers et al., 2008; Uyarra and Ramlogan, 2012). Thus it is proposed that the theoretical hypothesis for the study should be that:

The built environment and associated property market institutions play an important role in the development of niche sector digital technology clusters.

2.5.2 Conclusions and the way forward

Overall, there is a demonstrative deficiency of relevant data-rich cluster studies (Ketels, 2009; Osman, 2015), and those that do exist are single sector studies, biased in respect of the creative industries (Pratt, 2011; Champion, 2010). Whilst useful, the conclusions of these single sector studies are unlikely to be transferrable. They contribute to the already scattergun approach to cluster interventions and a failure to provide an adequate evidence base of primary research to validate ideas and concepts to the detriment of cluster theory and its application. These insights justify an exploratory study into the overlap between digital niche sector working practices and behaviours and the local built environment, which will provide the opportunity to contribute to some of the outstanding theoretical debates and fill many of the identified research gaps whilst at the same time testing the study's theoretical hypothesis. The approach and methodology are described and justified in the following chapter.

Chapter 3 Methodology: the research approach and design

3.1 Introduction

Having identified the theoretical hypothesis for the study, the purpose of this chapter is to justify and describe the exploratory approach to the research, including the details of the tools and practices employed.

The chapter consists of six sections. Following the introduction, Section 3.2 justifies the approach taken, Section 3.3 provides an outline of the stages of the research process, Section 3.4 details the response rates of the interview sampling process, Section 3.5 reflects on the study's limitations and Section 3.6 is a summary check on the credibility of the methodology.

3.2 The research approach

My theoretical position as stated in Section 1.1., is that "place" has a greater role to play in the development of digital technology clusters than has hitherto been recognised. The cross disciplinary literature review has shown that this idea is likely to have validity. Having undertaken both a top down and a bottom up exploration of the literature, the review has honed in a broad core theoretical hypothesis which proposes that the built environment and related property market are important in terms of digital cluster development.

In order to test the hypothesis, and gain comparative contextual insights into the character and behaviours of digital technology clusters, it was decided that an overall understanding of the working practices and behaviours of clustering digital technology companies, their locational criteria and how they implicate workspace demand was needed. At the same time, it was important to interrogate the local context in terms workspace supply and other potentially influential built environmental factors. The literature review revealed the paucity of research into this academic area, which suggested that exploratory research would be appropriate. The research scope is summarised in Figure 3.1 below:

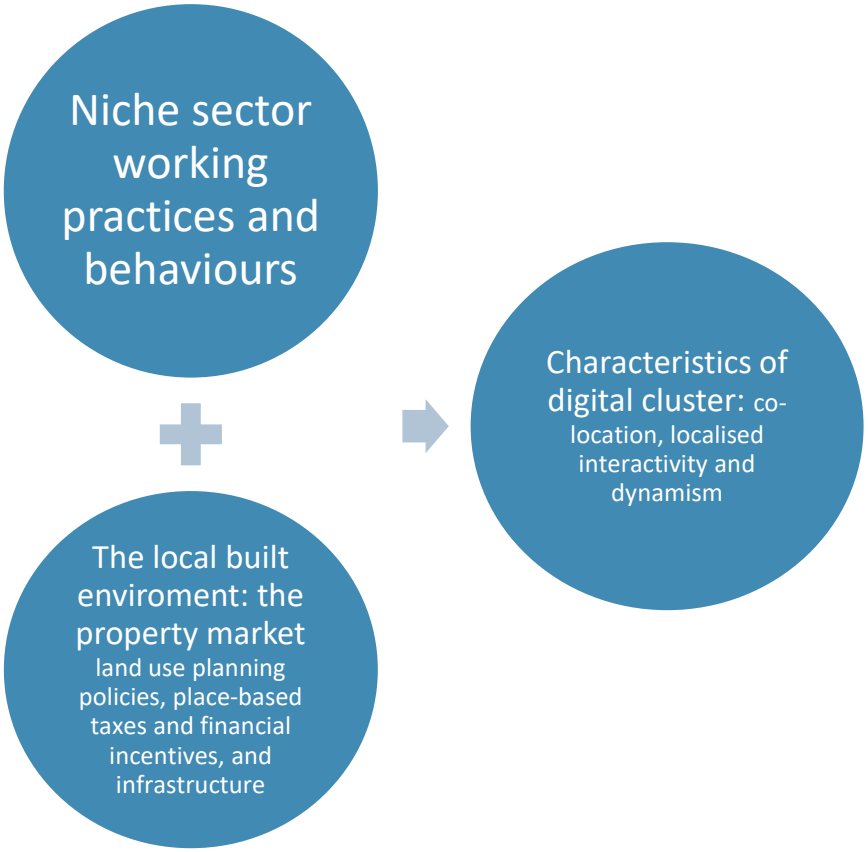


Figure 3.1 The research scope

The characteristics of the clusters to be analysed were identified in the literature review, Section., 2.2.1 as part of the definitional basis of both a general cluster i.e., co-location, face-to-face interactivity and dynamism and a digital cluster in particular (section 2.3.1). The study would be based on a number of exploratory case studies, the outputs of which would be analysed according to two guiding research questions. The first, aimed at developing an understanding of the characteristics of the chosen clusters, niche sector workspace needs and the relevant local built environmental context, thereby fulfilling the first and second of the study's research objectives (Section 1.0), asking,

- **How do niche sector technology business working practices and the built environmental features of place impact digital technology cluster characteristics?**

Secondly, in order to refine the developed understanding and with a view to developing a sound basis for policy intervention (study objective 3), identify,

- **What are the features of the local built environment and associated property market institutions which afford or constrain digital technology cluster development?**

3.3 Justification of the study approach

The research approach is explore a number of digital technology clusters, thereby creating a preliminary evidence base (study objective 1), which would form the basis for thematic analyses, based on the three identified cluster characteristics (Section 2.1) , co-location, local face-to-face interactivity and dynamism (study objectives 2), and could potentially direct future research and interventions (Stake, 1978; Soy, 1997; Jacobson, 2002; Yin, 2009; Easton, 2010; Woodside, 2010), thus fulfilling objective 3. The primary dataset is semi-structured business interviews or "a conversation with a purpose" (Elyes, 1988) to enable the open exploration of firm locational behaviours, preferences and strategies (Crang, 2005). This dataset is supported and corroborated by property-market and planning data, in the form of statistics, policy documents, and site observations. Such a broad dataset necessitates a mixed-methods form of data gathering and analysis (Johnson et al., 2007). A mixed-methods approach is defined as "an intellectual and practical synthesis based on qualitative and quantitative research", and is considered by some to be the most informative and complete form of research combining the pragmatism of quantitative analysis with the inference techniques of qualitative research (Johnson et al., 2007: 28). The need for a mixed-methods approach to exploratory research pointed to the use of case studies for the investigation. Indeed, in the words of Yin (2009: 18), clusters would make good subjects for case study research, which he defines as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". The case study approach is ideally suited to subjects which are complex and idiosyncratic (Welman and Kruger, 1999) and where the interaction between a phenomenon (the cluster) and a specific context (its built environment) is to be understood (Jacobson, 2002).

The appropriateness of the case study approach is confirmed by the answers to four questions set by Benbasat et al. (1987:372), which need to answered in the negative to justify the approach. These are set out in Table 3.1.

Question	Answer
1. Can the phenomenon of interest be studied outside its natural setting?	No, a cluster is bound to its setting.
2. Must the study focus on contemporary events?	No, there is a developmental angle to the research.
3. Is control or manipulation of subjects or events necessary (or possible)?	No, the key participants – the clustering firms – are independent.
4. Does the phenomenon of interest enjoy an established theoretical base?	No, the interaction of clusters with their built environments has rarely been explored.

Table 3.1 The appropriateness of a case study approach

(Benbasat et al., 1987: 372)

Objective three of the study is to produce a transferable evidence base for the development of cluster management interventions. This suggests a multiple case study approach (Benbasat et al., 1987). Many niche sector cluster studies are based on an in-depth study of a single case study (for example Champion, 2014; Clare, 2013); however, as described in Section 2.3, whilst these studies are valuable, they have limited transferability (Hodkinson and Hodkinson, 2001). A comparison of case studies would assist in deriving some generic insights and the transferability of potential intervention design, (Kaarbo and Beasley, 1999). The data-rich outputs of the approach fit with my study objectives, and the recognised need for more substantive cluster-based evidence to assist with developing local interventions (Nathan and Vandore, 2014; Osman, 2015).

There are well-documented limitations to case study research, including bias and lack of rigour (Miles, 1979; Yin, 2009; Krusenvik, 2016), for which I was vigilant throughout the planning and implementation of the study, as discussed in Section 3.5.

3.4 Research outline

Replicating classical guidance in respect of qualitative research (George, 1979), the research outline is summarised in broad stages in Figure 3.2 and described by section below.

Research process stage	Mechanism
3.3.1: Identification and confirmation of research questions	Literature review Pilot study
3.3.2: Identification and confirmation of key variables	Literature review Pilot study
3.3.3: Case study selection	Desk top research Pilot study
3.3.4: Development of the interview guide and coding protocol	Literature review Pilot study
3.3.5: Data collection – primary and secondary	Face-to-face interviews Direct observation Telephone calls Desktop research
3.3.6: Secondary data collection	Retrieval of property market and planning data Telephone calls with land professionals Site visits and photographs
3.3.7: Data analysis	Coding of interview transcripts Analysis of property market data Triangulation Case study production Comparative thematic analysis of case studies

Table 3.2 Outline of the research process
(after George, 1979)

3.4.1 Identification of key variables

The literature review and research questions point to two key variables, digital niche sector and the built environment, represented by firm interviews and built environmental data respectively. The pilot study was undertaken between February 2017 and May 2018, which tested the variables. Thereafter modifications and refinements of the approach and the research design could be undertaken prior to the main study (Atkinson and Oleson 1996, Yin 2003).

3.4.2 Case study selection

The case studies needed to allow for variable representation and variety to make causal inferences (King et al., 1994). “Digital niche sector” had to be represented by diverse sectors, whilst “place” needed to be represented by diversity of built environments.

Digital niche sector selection

The basis for niche sector selection were the Tech Nation UK annual reports (Tech City and Nesta, 2016; Tech Nation, 2018) and the UK Games Maps (Mateos-Garcia et al., 2014, 2016). The first step was to identify digital niche sectors for study. This was limited to two, which would provide a desired range for comparison and would be practical for handling. This was tested successfully through a pilot study. Cybersecurity and digital games were identified as possibilities likely to reflect the creative and scientific extremes of the technological niche sector portfolio. A desktop research comparative analysis represented below, confirmed that there would be sufficient cluster population and variation between populations for the study's purposes (Table 3.3), (Karbo and Beasley, 1999).

Cybersecurity	**Digital Games**
At least 5 distinctive clusters	At least 6 distinctive clusters
Growing fast	Growing fast
Competitive & innovative	Extremely competitive & innovative
Shortage of skills	Shortage of skills
Collaboration needs currently unknown	Collaboration with creative companies is important
Broad subsector providing products and services. Role of platforms not so evident	Platform-based diversification
Unknown effect of courses on location	Courses have a role in cluster location
Customers location important	Worldwide customer base
Urgent need to keep up to date	Access to skilled human resources is overriding need
The role of finance is unknown	Seems to be a role for finance in location
Secretive culture	Fun-loving culture
Lots of home workers	Fewer home workers, need to be in the office. Very collaborative

Table 3.3 Comparison between niche sectors (similarities (green) and contrasts (orange))

A broad introduction to each digital niche sector is provided.

Digital games

The definition of the "digital games industry" tends to vary by report, however it is generally understood as comprising those firms which produce games and associated software for computers, mobile phones and tablets. It is a subset of the wider video games industry, which includes games made for consoles and arcade machines. The characteristics of the niche sector

include rapid change and innovation cycles, often driven by platform changes and consumer take up (Banks and Cunningham, 2013). This dynamism means that small firms are particularly vulnerable to "creative destruction": they develop and close, at a fast rate. This is one of the reasons for a reliance on the work-for-hire (or fee-for-service) business model. It is clearly a high-risk industry and the likelihood of economic and commercial success is quite small (Sandqvist, 2012: 149).

Figure 3.2 shows that the worldwide market for games grew quickly during the study period, with mobile games outperforming other devices. Games hubs tend to focus on one of two platform specialisations, iOS[13] for mobiles development or console game production (Mateos-Garcia et al., 2014).

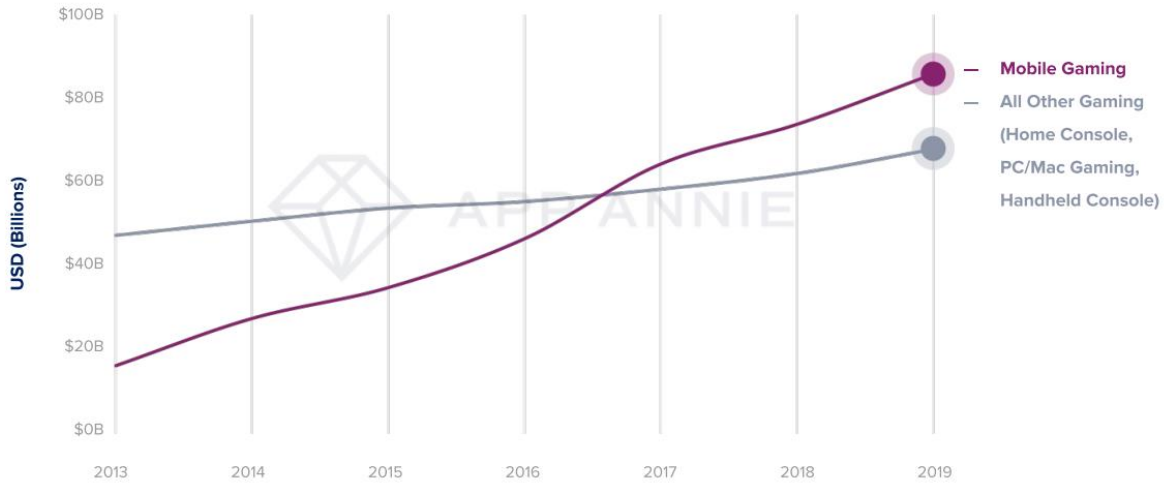


Figure 3.2 Global consumer spend on digital games.

Source: App Annie (2020) State of Mobile Report

The UK games market is the sixth largest in the world after China, the US, Japan, South Korea and Germany, and is similarly dominated by games for mobile phones, which comprises 41% of the total market, a value of $56.4 billion, and growing at a rate of 20% year on year (UKIE video games fact sheet, 2018). Mobile games are generally developed in conjunction with publishers and agencies, whilst other forms of games are independently developed and known as "indies".

Cybersecurity

The cybersecurity niche sector is defined as the "protection of systems, networks and data in cyberspace" (www.itgovernance.co.uk). The number of active firms in the UK grew by 44% to

[13] iOS is a mobile phone operating system developed by Apple Inc.

1,200 between 2017 and 2020, with an increase in sales of 46% for the period, worth £8.3bn and contributing £3.7bn to the UK economy. Fifty-five percent of firms are classed as being micro (fewer than 10 employees), whilst only ten percent are large (over 250 employees), (Department for Digital, Culture, Media and Sport (DCMS) 2020).[14] The market is very competitive and innovative in order to keep up with the accumulating cybersecurity threats. Whilst the larger firms remain the "arms based" companies such as BAE Systems and QinetiQ, small firms are proliferating as the sector has diversified into numerous more finely focussed niches. This trend has led to the sector encompassing a broad range of skills and an inability to switch jobs easily between companies (Christensen, 2011).

Cluster selection

Having honed in on the niche sectors, a long list of clusters was identified using the Tech UK reports as a basis and then supplemented with niche industry sources: the UK cybersecurity forum and the McKinsey Study (2014) for the cybersecurity niche sector, and work sponsored by Nesta and UKIE (Mateos-Garcia et al., 2014) for digital games.

Clusters were compared on the basis of firm population size and also in terms of built environmental variables, the aim again being to ensure variety of the variable (Tables 3.4 and 3.5).

Cluster location (local authority)	**No. of firms (UK Cybersecurity website 2018)**	**Total office space (2015–2016) in 1000m²**	**Average office rental value per m²**	**Broadband speed in Mbits (Ofcom Connected Nation report, 2016)**	**Cost of transport (Tech Nation report, 2014), as % of total business costs**	**Average house prices in 2017 (Land registry)**	**Date of local plan**
Bristol & Bath	105	1126 (Bristol)	£134 (Bristol)	6.4	20%	£260,270	2011 (Bristol)
Malvern Hills	110	51	£80	5.0	11%	£253,212	2016
Oxford City	142	369	£129	6.1	23%	£426,393	2020
Reading	Unknown	545	£113	5.9	43%	£305,213	2019
London Borough of Tower Hamlets[15]	Unknown	2467	£130–£275 (2007)	6.9	57%	£561,276	2020

Table 3.4 Key cybersecurity clusters and built environment indicators

[14] https://www.computerweekly.com/news/252477508/UK-cyber-security-sector-worth-more-than-8bn

[15] The London Borough of Islington costs used as a proxy for broadband speed and transport costs.

Cluster location (local authority)	No. of firms (Nesta/ UKIE, 2014)	Total office space (2015–2016) in 1000m^2	Average office RV per m^2	Broadband speed in Mbits (Ofcom Connected Nation report, 2016)	Cost of transport (Tech Nation, 2016), as % of total business costs	Average house prices in 2017 (Land registry)	Date of local plan
Brighton & Hove	63	423	£130	6.0	20%	£353,176	Pt 1 2016 & saved policies 2005
Guildford	63	305	£157	4.8	Unknown	£437,728	2019
London Borough of Islington	Unknown	1458	£228	6.9	57%	£615,100	2011
Warwick & Leamington Spa	Unknown	340	£118	5.2	52%	£294,123	2017

Table 3.5 Key digital games clusters and built environment indicators

The long list in each case was shortened to three diverse case studies for each niche sector. Following the pilot study, when the practicalities of the interview process – including response rates, interview times and travel times became apparent, it was decided to limit the study to two case studies for each niche sector for practical purposes. This provided four case studies for comparison, which as it happens is a number recognised as "working well" in multiple case study research (Eisenhardt, 1989: 545).

The final case study selection process was undertaken by simplifying the built environmental variables on a costs basis to assist with comparison, seeking to produce the greatest contradiction between places, or "theoretical replication" (Yin, 1984: 42). The "costs" analysis would also be well aligned with business locational strategy decisions a key output for the study.

Cybersecurity	Commercial rents	Transport costs	Housing costs	Digital speed
Bristol & Bath				
Malvern Hills				
Oxford City				
Reading				
London (proxy: the London Borough of Tower Hamlets				

Digital Games	Commercial rents	Transport costs	Housing costs	Digital speed
Brighton & Hove				
Guildford		Unknown		
London (proxy: the London Borough of Islington				
Warwick/Leamington Spa				

Key: relative values	High	Medium	Low

Table 3.6 Visualisation of built environment indicators by niche sector

Based on Tables 3.6, low-cost Malvern and high-cost London were chosen for cybersecurity; whilst medium-cost Guildford and high-cost London (represented by proxy London boroughs) were chosen for digital games.

Outline description of the four clusters

The locations of the four clusters are shown in Figure 1.1.

Digital games clusters

The chosen digital games clusters were Guildford and London. Guildford is a market town of some 80,000 people (2011 census), which lies 50km south-west of London, and has developed as a centre for an independent-based ("indie") games industry. London is the European centre for virtual reality (VR) development, growing at 34% pa. Guildford has been the home for an indie-based games industry specialising in console games since the 1970s. It is recognised as a cluster on the UK Games Map (Mateos-Garcia et al., 2014 and 2016), albeit data is hard to come by. Successful Guildford games companies include 22Cans, Bullfrog, Criterion, Lion-Head Studios, Electronic Arts (one of the largest video games publishers in the world), Kuju Entertainment and Media Molecule. Guildford was the home of Microsoft's UK studies for a period, and is the only

games cluster in the UK providing a home to two of the top ten UK games companies (Guildford Borough Council, Economic Strategy 2013–2031). The London cluster, by contrast, is one of the UK's fastest growing computer games development clusters, consisting of about 19% of the UK games workforce London is the European centre for virtual reality (VR) development, growing at 34% per annum, (Togni, 2015). Whilst London is home to many games companies, it has not hitherto been associated with the world's most successful games. According to the Evening Standard, in February 2017 the most prominent London Games businesses were

- Space Ape Games,
- Ustwo (part of the Rocksteady Group), creator of the Monument Valley game, and
- Rocksteady, responsible for the Batman Arkham series.

Cybersecurity clusters

The cybersecurity niche sectors are represented by Great Malvern (shorted to Malvern for convenience throughout the study) and, again, London. London is a recognised hub for cybersecurity due to a large market base and a relatively secure place to operate (Burgess, 2017). According to a recent fact sheet (The City of London, 2020), London is the centre of global cyber-insurance, with one quarter of all insurance passing through the city. London is also a home of most large international cyber firms. Increasingly British companies are making their mark, including Dark Trace (which has 22 offices globally and is valued at $400 million), Egress Ripjar, Panaseer, and Digital Shadows.

The contrasting cybersecurity cluster in Malvern is development-centred. Malvern is a market town with a population of some 30,000 (2011 census), located in the West Midlands, some 225km from London. Malvern and nearby Worcester combined are recognised as a centre of tech start-ups, with some 72 starting up between 2011 and 2015, one of the highest rates in the country (Tech Nation, 2017). Malvern was the home of the government's telecommunications research centre, the Telecoms Research Establishment (TRE), which moved to Malvern in 1942 during the Second World War, joining with the Royal Radar Establishment (RRE) and in 1976 with the Signals Research and Development Establishment to form the Royal Signals and Radar Research Establishment (RSRE). The combined organisation was partially privatised in 1991 becoming the Defence Evaluation and Research Agency (DERA). Cybersecurity was a major part of its remit. In 2001 DERA was also partially privatised, and the new organisation became QinetiQ. Subsequently, there have been rounds of cuts and job losses. But many ex-employees continue to live in the area, and work in the cybersecurity sector.

3.4.3 Development of the interview guide and coding protocol

The object of the firm interviews was to understand their locational strategies, cluster experiences and view regarding their built environments . The interviews were semi-structured in nature, which maintained the degree of openness required for exploration and the emergence of issues that were important to the participants, but also kept the interviews focused (Carson et al., 2001; Denscombe, 2010). A guide was employed to help direct the interviews and to serve as a basis for developing the coding protocol for the subsequent data analysis. The guide was tested in terms of its length and validity as part of the pilot study. A copy of the guide is included in appendix B. The nature of the thematic content and its purpose was broadly as follows:

1. **Introduction** to the interviewer and the purpose of the study. Describe what is meant by a cluster. Provide assurance re. anonymity of the data and discuss any privacy issues. Offer to share the results and a copy of the finished study.
2. **Business details.** Firm background information, e.g., products, customers, supply chain requirements, size, structure and turnover. Some details on the development of the business, when and where was it started? How has it grown? What is the likely future scenario? Employee travel to work area. Easy short questions designed to help reassure the interviewee and gain rapport (after Valentine, 2005).
3. **Built environment description.** Discuss current premises, size, quality, rental levels, tenure, infrastructure; location. Discuss the property and infrastructure needs of the business and how well have met company needs over time, including the future. Draw out any specific comments on the commercial and residential property market, the role of the local authority in terms of planning, non-domestic rates and infrastructure provision; internet provision and other infrastructure requirements.
4. **Clustering information.** The importance of the location, and the cluster specifically. What are the organisations key relationships? Are they local (within the cluster), regional, national or international? How has time effected these relationships and the relevance of the location? How may they change in the future?
5. **Other.** The chance for the interviewee to raise concerns possibly overlooked by the interviewer.
6. **Conclude.** Give thanks and offer to share results.

The guide was sent as part of a bundle of material to the interviewees prior to the interview, for background and to help identify the appropriate person for the interview. Thereafter, the guide provided the structure and direction for the coding protocol adopted for the analysis of the

transcripts, facilitating the identification of firms' size, supply chain, relationships, knowledge flows and locational strategies in particular, as recommended by George (1979) and Yin (2003).

3.4.4 Primary data collection

Primary data collection related to the business interviews. Care was taken throughout regarding the cataloguing and storage of the data and associated information, such that it remained anonymised but could easily be identified and retrieved for checking or future use. A carefully planned process for the data collection was undertaken and tested through the pilot study.

Identifying and contacting participants

A long sample list of companies was developed for each case study, based on a representative postcode. This was done through a combination of techniques including web-based research and referrals from local contacts. Contact was made by email, telephone and through obtaining introductions, either through a local cluster champion, or by attending relevant exhibitions or networking events. It was important to ensure that the evidence base for the data in each case study was developed on the same basis, to ensure credibility and rigour in the comparison process. The interview response rates needed to be similarly reflective of their cluster populations, and interviewees needed to have the same status in the firms throughout.

The difficulty with this exercise was establishing the total cluster population figure for comparison. The figures used for case study selection were considered to be out of date, and did not exist at all for the London based clusters. However, my firm selection process entailed an exhaustive hunt for firms, such that it is considered that my developed niche sector population figures were the most up to date available. Table 3.7 compares the interview response rates to my cluster total population figures.

Cluster	Total niche sector population for contact	Interviews conducted	Response rate in terms of identified population
Guildford	45	10	22%
Malvern	32	10	31%
London games	64	12	18.8%
London cybersecurity	93	10	10.6%

Table 3.7 Interview response rates

It is noticeable that the response rates for both London clusters are lower than for non-London clusters, due to the larger total niche sector populations.

There did not appear to be any strong sampling issues. It is possible that personal bias could have crept in, but it is felt that this was not the case as sampling was very much a question of which firms responded positively to their invitations. This, of course, is a recognised problem of the sampling technique, but is extremely difficult to overcome (Krusenvik, 2016). In the event, it was felt that due to the exploratory nature of the study, the issue was not sufficiently misrepresentative as to affect the outcomes.

Response rates for each case study are described in more detail in Section 3.5. Difficulties in identifying participants and mechanisms for overcoming the difficulties are discussed in Section 3.6.

Pre-interview preparation

A bundle of information was sent to the participants prior to the interview, including a copy of the ethical consent for the study, a short description of the research project, the interview guide and the confidentiality clause.

In preparation for the interviews, research was undertaken on the firms, and the general economic, industry and place-based background (Yin, 2004; Chetty et al., 2013).

Interviewing

The majority of the interviews were undertaken face-to-face in the offices of the firms, and recorded. They lasted about an hour. Interviews were undertaken with representatives of forty-one firms, ten for each of the Guildford games cluster and the Malvern and London cybersecurity clusters, and twelve for the London games cluster, over the period between February 2018 and June 2019. The interviews are listed in Appendix B and summarised in Table 3.8 below. Locational decision makers were interviewed in all cases except for three in the London cybersecurity case study. These respondents held strong views about clustering and their results were deemed relevant. The London cybersecurity interviews also differed in that it was difficult to meet the interviewees in their offices. Both these difficulties seem to reflect the working practices of the industry in London, and were often sales and marketing based. If phone interviews were undertaken, then they were followed up with a site visit to the offices. For each of the forty-one interviews, permission was obtained to record.

Case study	Total interviews	Locational decision maker	Gender M:F	Type of interview: Face-to- face in office: phone
Malvern	10	10/10	9:1	7:3
Guildford	10	10/10	10:0	7:3
London games	11	11/11	10:1	8:3
London cybersecurity	10	7/10	10.0	3:7

Table 3.8 Interview participant status

Notably, all interviewees apart from two were male, there was one female games managing director and one cybersecurity director. This cross section reflects UK IT sector statistics as described in Section 2.3.5.4.

Interviews were transcribed verbatim, and notes were added to the interview guides. Outputs were anonymised to protect the participants' interests.

Interview follow-up

A thank you note was sent by email, followed later by a summary of the findings by case study, which was sent to each participant with an invitation to comment.

3.4.5 Secondary data collection

Secondary data collection related to supportive and corroborative data. Again, care has been taken with storage and cataloguing to ensure it can be retrieved.

Direct observation: site visits and photographs

Site visits were essential for the visualisation of the workspaces and their contexts. Malvern was visited at least four times and London five times, with each visit taking a day. Guildford is home and therefore visited regularly. Photos were taken of the participants' workspaces. Together this data was collected with data on the nature of the space, the neighbouring tenancies, local facilities (including restaurants and bars), the local built vernacular, transport facilities and neighbouring institutions. The site visits also afforded the collection of data relating to the market for workspaces, including local commercial property agent details, and the quantity and quality of workspaces let and available for let. The material played a key role in terms of corroborating the interview outputs, but also provided valuable inputs for the built environmental analyses.

Conversations with land-based professionals

To support, inform and corroborate the property market and planning data (Yeung, 1997; Silverman, 2000; Bryman, 2001; Woodside, 2010), telephone conversations and one meeting were undertaken with key built environmental informants, including estate agents, developers, investors, the local planning authority and workspace managers. The list is included in Appendix B and summarised in Table 3.9. below.

	Guildford	Malvern	London	Total
Commercial property agents	3	3	5	11
Local authority planners/economic development professionals	1	2	2	5
Workspace managers	1	2	1	4
Total	5	7	8	20

Table 3.9 Built environmental professional interviews

A total of twenty interviews were undertaken. There are rarely more than two specialist agents operating in a property market area, so it was felt that the number of conversations was comprehensive. It was necessary to identify and speak to more than one agent per case study to gain a consolidated, balanced professional view of each area.

Property and planning related information

Property market data was obtained using Costar data.[16] Costar data is a property market industry standard, used by most property market businesses. Current planning policies and supporting evidence are publicly available and were obtained through the appropriate local authority websites.

3.4.6 Data analysis

Several data analysis techniques were employed throughout the study, reflecting its mixed-methods approach and the goal of a delivering a rich evidence base.

[16] Costar is a well-established and recognised commercial property market database, used by the majority of property valuers and researchers in the UK. http://www.costar.co.uk.

Coding analysis of interview transcripts

The coding process consisted of several rounds of reading the transcripts sentence by sentence. In the first round, annotations were made on the transcripts, or "open coding "system (Crang, 2005), which became pointers for subsequent rounds. Thereafter, reference was made to the research guide and hence to the research questions, to establish three broad themes, plus an "other" category, which helped to collect unique useful points (Table 3.10). These themes began to break down after subsequent rounds of reading. External or etic codes and internal or emic codes were identified, as represented in Table 3.10.

Research guide category	External or etic codes	Internal or emit codes
Business details (B)	1. Size 2. History 3. Number and location of branches	4. Product 5. Key supply chain relationships
Built environmental and location details (BE)	1. Workspace locational history	2. Workplace preferences 3. Access to skilled labour 4. Transport connectivity 5. Property markets 6. Planning 7. Housing 8. Internet 9. Local business taxes
Cluster comments (C)	1. Co-location and proximity 2. Local interactivity 3. Distant interactivity 4. Virtual interactivity	5. Shared premises 6. Property market information 7. Niche sector networking
Other (O)	Unique	Unique

Table 3.10 Thematic coding for transcripts

Verbatim quotations were highlighted and included in the thesis, as these are the best way of demonstrating that the outputs are the views of the participant rather than the researcher. This was an interactive, iterative process which involved working with the data, the guides and the research questions, and included referencing and interpreting qualitative data, such that the use of coding software such as Nvivo[17] was not considered appropriate.

[17] Nvivo is a qualitative data analyst computer software package produced by QSR International. Http://www.qsrinternational

Property market analysis

Graphs of office property market trends were developed for each case study for a period that reflected the stages of cluster development. The trends related to standard property market variables, including vacancy rates and rental levels. Office or workspace data was divided into four qualities, with 1* and 2* reflecting low-grade space in need of refurbishment, 3* being better quality but requiring some refurbishment, and 4* which is fully refurbished and of good quality.

Planning policy analysis

Planning policies are recognised in the literature review as being central to development of the built environment (section 2.4.2.2 and table 2.2). It is therefore important to the study that the consequences of the local planning policies on the built environment and potentially the locational decisions of the interviewed firms in each case study, are fully understood. To this end planning polices impacting the availability of employment land and the preferred workspaces of the niche sector businesses in question were targeted and spatially evaluated by reference to the cluster maps for each case study. Both the age of the content of the policies and the year of implementation were of interest. An historical evaluation was also undertaken with employment land monitoring reports referenced.

Production of case study narratives

Four evidence-rich case studies were developed in narrative form, using comparative structures based on the research questions and the research guide to facilitate later analysis (King et al., 1994). The mixed sources of data, both qualitative and quantitative, overlapped and corroborated each other, a recognised benefit of a mixed-methods approach for triangulation purposes (Curtin and Fossey, 2007).

Thematic analysis of case studies

Three thematic analyses were undertaken, reflecting the three identified characteristics of clusters (Section 2.2.1), that is the significance of the built environment in co-location, the significance of the built environment to local face-to-face interactivity, and an exploration of the interplay of the property market for workspace with cluster development. Patterns, similarities and differences were observed by tabulating and comparing the case study outputs. The interview material was supported and corroborated with the secondary data, wherever possible. A process of refining and focussing the outputs was undertaken. Business rates, internet connectivity and the property market for housing were found to have little influence on firm locational behaviours

and were therefore excluded from the analytic outputs. The analyses were discussed and revised through a collaborative process with my supervisors.

Enfolding the findings in relation to the literature

A deeper understanding of the thematic analyses was developed by reference to the literature background, in the manner envisaged by Eisenhardt (1989), producing the interpretation of the findings reproduced in the following chapters of this thesis.

3.5 Interview sampling outcomes and response rates

Response rate and sampling information are reproduced for each case study. The number of employees is included for information but disregarded as a comparative figure, since games companies in particular are very volatile, and the number does not appear to relate to the maturity of a firm in the traditional sense.

Malvern cybersecurity

Malvern cybersecurity firms	Interviewee status	Nature of company	Start date of company	Age of company in years	Number of employees
1	Founder & CEO	Software development and consultancy	2009	10	53
2	Director	Product development and consultancy	2012	7	30–40
3	Founder & CEO	Software development & consultancy	2003	16	25
4	Founder & CEO	Tech accelerator	2017	2	2
5	Founder & CEO	Start-up, software and consultancy	2019	0	2
6	Founder & CEO	Voice biometrics, software development and consultancy	2006	13	11
7	Managing director	Technical & management consulting	2013	3	4
8	Founder & CEO	Blockchain applications	2017	2	2
9	Business development manager	Cybersecurity certification & assurance	2012	7	7
10	Technical director	All forms of cybersecurity support	1999	20+	Large

Table 3.11 Details of cybersecurity companies interviewed in Malvern

The Malvern firms focused on software development and consultancy, supporting a variety of different industries. Interviewees were all CEOs or managers.

Guildford games

Guildford firms	Interviewee status	Indie/mobile	Start date of company	Age of company in years	Number of employees
1	Founder & CEO	Indie	2016	3	1–70
2	CEO	Video game publisher	2011	8	35
3	Executive director	Indie play station and console developers	2008	11	35
4	Founder & director	Indie	2016	3	10
5	Founder & director	Indie VR design software	2016	3	1
6	CEO	Indie VR software computer animation	2009	10	50–100
7	Managing director	Indie VR	2016	3	8
8	Managing director	Indie	2012	6	Large
9	Joint managing director	Indie start-up games space & mobile developer	2016	3	1
10	Founder & CEO	Indie, animation software	2006	13	11–50

Table 3.12 Comparison of interviewed firms and participants for Guildford games cluster

Most game firms in Guildford are independent (or indie) developers. Seven of the Guildford firms are under ten years old, which reflects their heightened volatility.

London games

London games firms	Interviewee status	Nature of business	Start date of company	Age of company in years	Number of employees	Location
1	Founder & CEO	Games based advertising	1995	24	11–25	EC1
2	Founder & operations director	Indie console developer	2013	3	25	EC1
3	Design director	Indie developer	2013	3	3	EC1
4	Creative director	Mobile developers	1999	20	60	EC1
5	Freelance creative director	Games project manager	2014	5	1	EC1
6	Founder & co-director	Indie	2014	5	3+	Remote
7	Founder & CEO	Indie	2008	11	10+	Remote
8	Managing director	Games agency	2009	10	35	N4
9	Technical director	Creative studios	1997	22	75–80	EC1
10	Managing director	Work for publisher	2004	15	25	SE1
11	Founder & CEO	Indie	2001	18	25	SE1

Table 3.13 Comparison of interviewed firms and participants for Clerkenwell games cluster

The London games firms were a mix of advertising agencies which had developed a focus on games, and younger firms who were indie developers, reflecting what is known about the population as a whole.

London cybersecurity

London cybersecurity firms	Interviewee status	Nature of business	Start date of company	Age of company in years	Number of employees	Location
1	CEO	Cyber talks	2018	1	1	Remote, SE1 address
2	CEO	Recruitment & vendor	2006	13	10 full time, 200 associates	Remote, WC1 address
3	Product marketing manager	Software development and consultancy	2016	3	55-60	Nottingham & EC2
4 & 5	Vendors	Vendor & recruitment	1998 (various mergers etc)	21	20 vendors	EC1 (US & Israel)
6	Head of sales	Certification	1980s, 2004 in London	30 +	20 vendors	US-based
7	CEO	Software development and consultancy	2014	5	150	SE1
8	CEO	Software development and consultancy	2019	0	1	Remote
9	Founder & CEO	Vendor	2017	2	1	EC1 & remote
10	Director of business development	Vendor	Approximately 2008	12	20 in London	US-based, multinational

Table 3.14 Comparison of interviewed firms and participants for London cybersecurity cluster

London cybersecurity companies were varied: three of the ten were software developers and consultancies, whilst four were vendors, and two were additionally involved with cybersecurity-related recruitment. At least four had international headquarters, and three worked remotely in the UK.

3.6 Study limitations

3.6.1 Data

Case study selection

The long list of case studies (Section 3.4) which formed the basis of selection would have ideally been generated from the same source, to ensure full comparability. This was not possible due to the lack of existing sector-based research, which stems from a lack of SIC-code identification with digital niche sectors (Section 2.3.1). The identification process was as comprehensive and rigorous as possible in the circumstances, with issues only pertaining to total population characteristics (Section 3.4). This is not considered a serious problem for a qualitative study, since the central criterion for qualitative studies is the richness of the information and data (Baxter and Eyles, 1997).

Built environmental data

Confirmation of the validity of the built environmental indicators was undertaken following a pilot study. The results are reproduced in Table 3.15.

	Planning policies	**Employment land supply**	**Property rental levels**	**Property yield rates**	**Property vacancy rates**
Source	Local authority	Local authority	Costar data	Costar data	Costar data
Areal data unit	Local authority	Local authority	Local authority or urban settlement	Local authority or urban settlement	Local authority or urban settlement
Primary or secondary data source?	Secondary	Secondary	Primary	Primary	Primary
Validity	Y	Y	Y	Y	Y
Bias	N	N	N	N	N
Appropriate	Y	Y	Y	Y	Y
Current	Y	Not always	Y	Y	Y
Manipulated	N	Y	N	N	N
Accuracy	Y	Y	Y	Y	Y

Yes: Y No: N

Table 3.15 The reliability of the proposed secondary dataset

Of consideration was that employment land studies were not always up to date, but this fed into the results of the study.

The main issue regarding data was that, for the London case studies, the areal representation of property market and planning policy material did not totally coincide with the identified clusters. Whilst there was property market data for Clerkenwell, there is none specifically for Shoreditch. Therefore figures for the "city fringe" sub-market area was adopted as a proxy. This was not felt to be a problem as the data reflected the property market that the firms were operating in, and provided the opportunity to observe more closely the differences between two clusters which were so closely juxtaposed with each other. The clusters were covered by a multitude of planning policies and under the jurisdictions of three or four planning authorities. This issue was overcome through thorough research to identify all the relevant planning policies for each area. The issue is partially mitigated by the fact that commercially related policies are largely covered by the London Plan (Mayor of London and the London Assembly, 2019) which is London-wide.

The components of the built environment that were of interest to the study changed through the study process. Having identified a comprehensive list at the onset (Tables 3.4 and 3.5), it was found that house prices, business taxes and internet connectivity proved to be of little importance to interviewees. On the other hand, transport connectivity, and workspace rental values and preferences featured strongly, and made for a good basis for comparison. Already, despite the acknowledged idiosyncrasies of "place" over time, some simplification of the many variables which could have been relevant (Wellman and Kruger, 1999: 191) had been undertaken, which assisted the focus of the study.

3.6.2 Sampling

The study sampled from within identified clusters, the purpose being to explore and identify cluster microprocesses and dynamics. I am alert to the fact that the results might have been corroborated by some sampling outside of the clusters, although this would have added complexity to an already complex study. This research gap is discussed as a possibility for future research in Chapter 7.

As described in Section 3.3.4, it is difficult to say how well the number of interviews represent the total niche sector population for each case study, as reliable total population figures are unavailable. I have compared the number of interviews with an identified total which was self-developed, which provided relatively high ratios for each case study (Table 3.7). Similar comparable niche sector studies have been based on fewer interviews, for example the study of Atherton (2003), who undertook qualitative research on four games sector clusters in the north of England, and based his research on a total of thirty-five interviews, ranging from seven to eleven

interviews per case study. My interview rate is higher and more evenly spread, making it more comprehensive and sound as a database for analysis.

It would have been optimal to have interviewed a representative cross-section of the firm populations in terms of size and maturity (Baxter and Eyles, 1997), but without comprehensive population data it is impossible to ascertain how representative the samples were. The final identification of firms was a muddled process, with the likely selection outcome being the result of both participant and researcher bias (Krusenvik, 2016). The result is a mixed sample cross-section (Figures 3.2 and 3.3), not untypical of qualitative research and a recognised limitation (Baxter and Eyles, 1997).

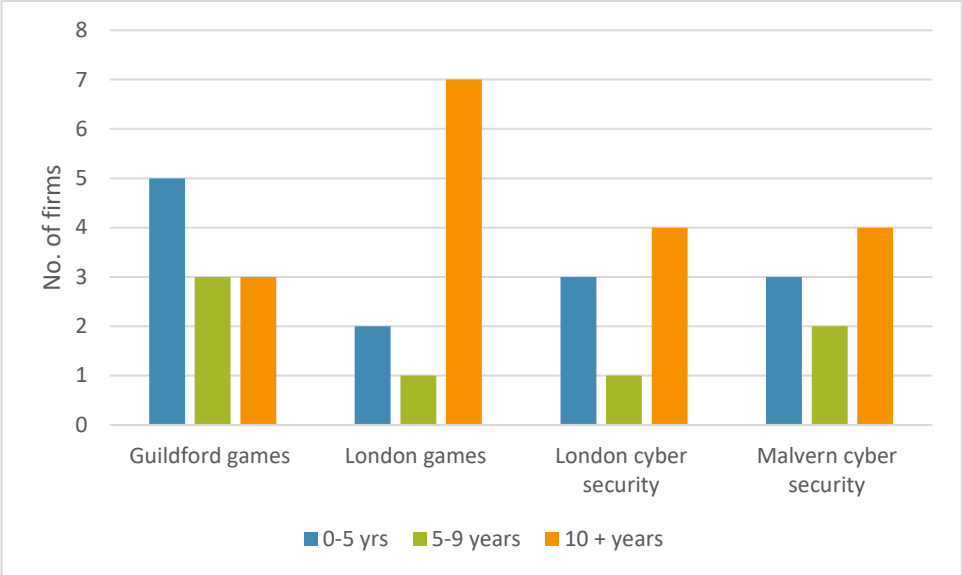


Figure 3.3 Number of firms by age per sample group

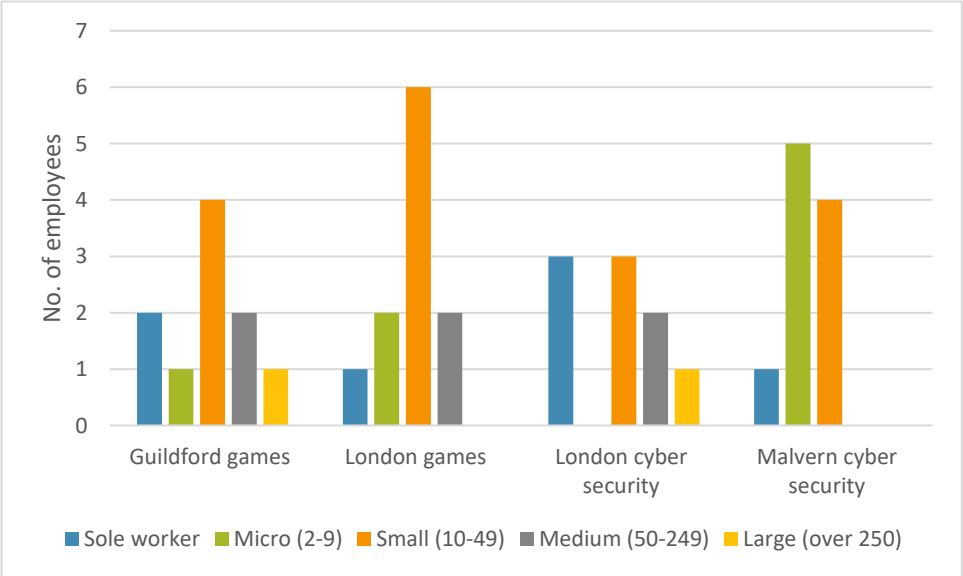


Figure 3.4 Number of firms by size per sample group

3.6.3 Interviews

Interview participants

London cybersecurity CEOs were especially difficult to reach, since many firms had branches overseas. This deficit was made up in one example, by undertaking two interviews with representatives of different departments to get a more comprehensive view from the firm.

Interview venues

The preferred venue for the interviews was the workspace of the firm. Table 3.16 records the venues by case study.

Case study	Total number of interviews	Interviews in firm offices	Interviews elsewhere in locality	Interview by telephone
Malvern	10	9	1	0
Guildford	10	9	1	0
London games	11	8	1	2
London cybersecurity	10	3	0	7

Table 3.16 Interview venues for each case study

London cybersecurity firms were particularly difficult to meet up with, due to their remote working practices. Where it was not possible to meet, a telephone interview worked well. The need to see the participants' workspaces was mitigated by participants sending photos through, together with internet research. Freelancers who were based at home preferred to meet in a café, which sometimes caused interfering background noise on the interview tape recording (Crow and Wiles, 2008). In these cases, follow-up telephone calls were made to clarify points.

Researcher positionality

My positionality in terms of being an "outsider" to the digital world and an "insider" in terms of the property world will also have had implications in terms of data gathering and analysis (Dwyer and Buckle, 2009). Throughout the interviews, I was aware of the possibility of personal bias creeping in, a recognised problem associated with qualitative interview research, because of the openness of the research which can encourage the "enthusiasm and personal interest" of the researcher to sway the questioning and the outputs (Valentine, 2005). The participants were naturally interested in my relationship with and interest in the digital technology sector, and so I felt it was important to make sure they did not feel threatened or that I had a vested interest. The

use of key cluster gatekeepers, usually cluster champions, to introduce me to firms helped a lot in this respect (Delaine, 2000; Campbell et al., 2006). My professional status as a planning and development chartered surveyor and a non–technology professional seemed to reassure them of my interest simply in being able to make policy recommendations to the relevant local authorities, which potentially could have a positive impact on their businesses. My "outsider" status to the digital industries was recognised and seen as non-threatening, but it may have meant that I overlooked some of the nuanced points in the interview data. My "insider" property world status helped me gather and reconcile the property market and planning data, not only through familiarity with the data but also confidence when speaking to the land professionals. Overall, I do not think my positionality posed any threat to the study, and may have facilitated it.

Participant bias and member checking

As described above, there may have been participant bias in the interview sampling outcomes. Member checking the interview data was done some months later when I sent a consolidated summary of my findings with case-study-appropriate appendices to each participant with an invitation to comment. Only a very few acknowledged the document, and none sent any detailed comments on the information.

3.7 Study quality and rigour

Tables 3.19 summarises the measures taken to ensure scientific rigour using a broad checklist for qualitative research (Baxter and Eyles, 1997).

Question	Method	Rigour safeguards	Issues
What was the natural history of the research?	A need for detailed transferable local evidence on the microprocesses of clusters A lack of attention to the built environment	Literature review generated, study aims and research questions.	
What data was collected and by what methods?	Face-to-face interviews Mixed property market and planning information Onsight survey and photographs	Ethics approval Anonymity secured through coding Pilot study Corroboration of data sets Participant member checking	Cybersecurity firms in London difficult to contact and meet as often working remotely Larger firms less responsive Low response rate and lack of responses to member checking
How was the sampling done?	Niche sector and place evaluations Firm identification	Detailed evaluations of potential clusters examined Pilot study	Case studies reduced from six to four for practical purposes
How was the data analysis done?	Comparative tables from coded transcription outputs Case study production Comparison with property market data	Pilot study Linkages between Interview guide and coding protocol Rigorous property market data Discussions with supervisors to ensure integrity	Property and planning areal bases did not always coincide with clusters
What results are presented?	Thematic narratives	Based on detailed thematic comparison charts of data-rich case studies. Discussed with supervisors to ensure integrity	House prices, business rates and internet were found not to influence location decisions, and were excluded from the results. Example of negative case analysis .
How credible and dependable are the data construction links?	Data construction linkages generated from the onset	Linkages preserved throughout from study aims, research questions, to interview guidance, to thematic narratives	

How credible is the theory?	Based on an extensive multidisciplinary theory	Literature review is comprehensive and cross-disciplinary Discussed with supervisors to ensure integrity	
How transferable are the findings?	Study was set up to produce transferable findings	Broad differences between variables identified to highlight variation and support transferability	

Table 3.17 Applied checklist for evaluating qualitative interview research

(Baxter and Eyles (1997: table 111), based on Rose (1982) and Lincoln and Cuba (1985))

The identified issues have been highlighted and mitigated as described in Section 3.5. It is recognised that they are reflective of the generally acknowledged limitations of qualitative research (Baxter and Eyles, 1997).

A second, more detailed checklist relating to the credibility of the data, Table 3.18, cross-references credibility criteria to the relevant sections of this chapter, and confirms that it was as credible as possible (after Lincoln and Guba, 1985).

Criteria	Definition	Strategies/practices to satisfy criteria	Chapter section response
Credibility	Authentic representation of experience	Purposeful sampling	3.2
		Disciplined subjectivity/bracketing	3.3.4
		Sufficient time in field to develop trust	3.3.4
		Triangulation	3.3.6
		Negative case analysis	3.3.6
		Peer debriefing (exposing data to respected colleagues)	3.3.6 & Table 3.17
		Referential adequacy (checking discounted material, what else might have worked)	3.3.6
		Member checking	3.5
Transferability	Fit within contexts outside study situation	Purposeful sampling	3.2
		Thick description (helpful for transferability)	3.3.5
Dependability (consistency)	Minimisation of idiosyncrasies in interpretation	Low inference deciphers	3.3.3
		Mechanically recorded data	3.3.4
		Multiple researchers	Table 3.17
	Variability tracked to identifiable sources	Peer examination	Table 3.17
		Triangulation	3.3.6
Confirmability	Extent to which biases, motivations, interests or perspectives of the inquirer influence interpretations	Audit trail products	3.3.4
		Thick description of audit process	3.3.4
		Autobiography	3.3.4
		Journal/notebook	

Table 3.18 Criteria for evaluating qualitative research

after Lincoln and Cuba (1985)

Based on the above, it is considered that the methodology has been scientifically rigorous and based on credible, sound data sources, which provide a dependable evidence base for the examination and response to the research questions and fulfilment of the studies aims. The outputs are rich, which will add to the aim of developing the evidence base of primary research into the developmental, locational and business needs of clustering niche sector digital industries. Furthermore, the focus on the bult environment allows for the development of specific niche sector cluster intervention approaches, the final objective of the study. The following chapters present the results of thematic analyses of the case studies: Chapter 4, “Co-location and the significance of the built environment”, Chapter 5, “Local face-to-face interactivity and knowledge flows in digital clusters and the effect of the built environment”, and Chapter 6, “An exploration of the interactions between digital clusters and their local property markets”.

Chapter 4 Co-location in digital technology clusters and the significance of the built environment

4.1 Introduction

This chapter presents the results of the co-locational thematic analysis. Co-location of businesses is, as observed in Section 2.2.1 is the most recognised characteristic of clusters. It implies geographic proximity or a short distance between businesses with complementarities (Boschma, 2005). The advantages of co-location are well documented (for example by Gordon and McCann, 2000; Marshall, 1920; Porter, 1990), yet the processes which give rise to co-location of firms in digital sectors have received less attention. We know little about the motivations and drivers behind the locational decisions of these businesses, and even less about the significance of the local built environment. Pertinent questions are: what are the reasons behind their workplace selections, and to what extent are these demands met by the availability of built form?

This chapter explores the factors driving the locational decisions of the digital businesses represented in the case studies. It is an enquiry into the characteristics of the working practices of the co-locating niche sector digital businesses, and how they influence their locational decision, noting any obstacles to their responses and how they adapted, whilst at the same time developing an understanding of how the characteristics of the local built environments have impacted the decision making responses.

The chapter relies on several terms and definitions relating to the workplace and the workspace. A workplace is defined as a place of work, for the most part a fixed physical location – including office buildings, schools, and hospitals – where employees gather to work under the same roof. A workspace is the physical space where the work is undertaken, synonymous with a work station, and is likely to differ by business life-cycle stage. It is important to identify whether a gradation of workspaces is appropriate by niche sector and business life-cycle stage. The property literature classifies as “start-up” space (for very young businesses); “move on” space (for start-ups facing their first expansion); and “corporate” space for larger more mature companies.

The approach is to firstly (Section 4.2) set the scene for each case study by describing the workplace settings of each case study cluster, including observations relating to the incumbent firms’ locational criteria and their comments regarding the advantages of co-location. Section 4.3 starts to consolidate and compare the outputs, probing whether and how workplace preferences are driven by differential working practices stemming from niche-sector business models and

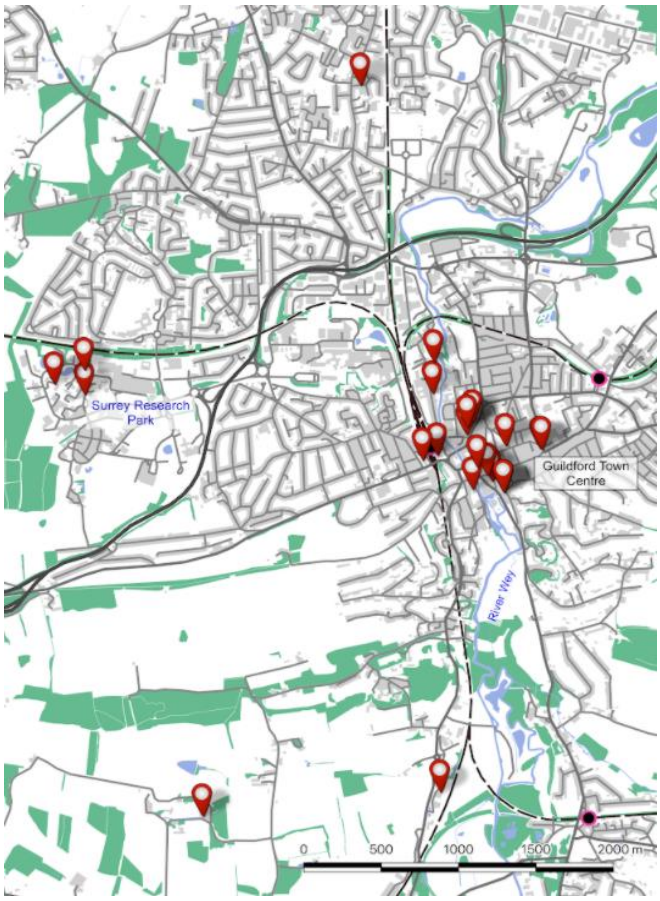
their life-cycle stages, with special emphasis on the role of built environmental characteristics. The next section, Section 4.4, consolidates the outputs, recognising the relative attractiveness of the locations and highlighting the types of adaptive behaviours that are employed to remain in the cluster. The concluding section revolves around answering the two research questions posed at the beginning of this section. By probing and describing the work place preferences and the drivers of co-location, this chapter helps to set the scene for the following investigatory chapters into face-to-face interactivity dynamics and the development of each of the case study clusters over time.

4.2 What is known about the co-locational dynamics of the case study clusters?

The four case studies represent differing built environments and clusters, as described in Section 3.3.2. This section develops the descriptions, highlighting cluster-specific nuances in terms of working practices and built-environmental factors, before describing the business responses to the question of co-location.

4.2.1 The Guildford games cluster

Guildford is a town of some 80,000 inhabitants (2011 census), and a hub of some 1000–1500 games professionals and sixty-three firms (Tech City and Nesta, 2016). As shown in figure 4.1, the games businesses are concentrated in the town centre within walking distance of each other and within an area of no more than one square kilometre. Some start-up businesses have located in a co-working space called Rocketdesk, in the out-of-town Surrey Research Park.



	Games company
	Railway station

Figure 4.1 Map of the Guildford games cluster

Source: author

This study largely focuses on the town centre businesses, but it is noteworthy that the survey found that businesses beyond the town centre, located up to fifteen miles away, still identified strongly with the town centre based cluster.

Figure 4.2 provides detail on the location of the town centre games businesses. They enjoy proximity to the station and a spectrum of interesting and often quirky workspaces, associated with one of the most attractive retail centres in the country (Harper Dennis Hobbs, 2019) and also a lively cultural scene. The firms appear to reflect the locational preferences of millennials (described in studies such as McDonald, 2015; Moos, 2013, 2016; and Lee and Lee, 2017), the Guildford games companies value easy access to public transport, so the town-centre workspaces with limited parking seemed to suit them. A Guildford-based commercial property agent explained that the games professionals “have a nosebleed if they are further than five minutes from the station”. Another explained that “millennials want to use the train, they don’t have cars either because they can’t afford it or they don’t agree with them”.

	Games company
	Railway station
	Conservation area
	Listed building
	Flood protection zone policy

Figure 4.2 Location of the Guildford town centre games businesses

Source: author

Figure 4.3 The historic high street of Guildford

Source: The Ivy https://theivyguildford.com/in-the-area/high-street/

The town centre is compact, with a historic built form, a cobbled high street, and rambling alley ways and interesting buildings, which the games companies seemed to enjoy and prosper in and which set them apart from other potential tenants. The companies inhabit a range of buildings, often reflecting their stage in the business life cycle: semi-industrial buildings near the station; historic, often listed buildings in the town centre; and modern buildings on the fringe of the centre. Typically they enjoy fitting their workspaces out in an urban and gritty look, seemingly a preferred and what appeared to be an emblematic style for the niche sector. Rocketdesk, the start-up space for games companies, was based in the out of town Science Park was similarly fitted out. The companies were notably quick to move into the town centre with growth and success, probably sharing “move on” space, in the semi-industrial buildings of Walnut Tree Close near the station. This stage in the business life cycle is a particularly vulnerable time for any growing company, where it is driven by employee expansion needs, but also forced to accept higher property-related overheads.

Figure 4.4 Semi-industrial workspace used by games companies in Walnut Tree Close, Guildford

Source: author

The games companies were generally indie developers (see Section 3.3.2). They expanded extremely quickly, generally based on a single project. The projects were especially vulnerable, and many failed. Walnut Tree Close, close to the river, has provided the growing companies with much-needed, relatively cheap, low tertiary-grade premises on flexible leases. The street has an industrial past, and its susceptibility to flooding meant that it has not been a popular location for other office or industrial tenants, and landlords have not been interested in investing or upgrading the buildings. Furthermore the council's flood protection policy zoning has prohibited the change of use of the buildings to residential uses, as shown in Figure 4.2. Since 1989, thirteen games firms registered themselves as having an address in Walnut Tree Close. At the time of the study it was the home of at least four companies. One such company CEO described his workspace proudly, saying that it was "just a shed and it floods".

The availability of the semi-industrial buildings has suited the development of the cluster well. The young games companies in particular did not want well-fitted-out offices, preferring to develop their own internal "rough" and "funky" look. Not only does this appeal to them, it also helps to cut down on costs and the time involved in a traditional workspace post-contract fit-out. These workspaces remain sufficiently flexible that staff can be "crammed in" according to project demands. The extra capacity associated with some of these semi-industrial spaces also served well those companies with games set in Virtual Reality (VR), needing the "walking around space" to physically try out their products.

The historic buildings of the central town centre, also inhabited by the games companies (figure 4.5), are protected by conservation area and listed building policies, (see Figure 4.2), so also tend to remain unaltered. It is difficult to alter or upgrade them either for higher-value residential use

or to add in the fixtures (including fit-outs and air conditioning) expected by other market sectors, a point developed below.

Figure 4.5 Heritage building workspace for games company in Guildford town centre

Source: onthemarket.com

Medium-sized, generally older games firms remain in the town centre, but prefer larger, more private workspaces, which they can fit out themselves and add facilities such as a cafeteria and "chillout" space.

Figure 4.6 Workspaces for larger games companies in Guildford town centre

Source: en.wikipedia.org

The inclusion of a cafeteria is popular, the suggestion being that despite proximity to external eating establishments, an internal facility is convenient for employees. Local agents saw it as a mechanism for attracting and retaining staff, and possibly limiting the exposure of employees to external interactions, these firms seemingly becoming increasingly product- and employment-

sensitive. Security is also a feature of the built spaces of larger firms, which preferred above-ground floor space, without company sign boards, and which sought to isolate themselves from other companies while remaining in the town centre. This secretive side of some games companies' working practices was also recognised by Pratt (2000) in his study of the games industry in New York. This study suggested that it is more of a feature of larger companies.

The historic character of Guildford and its built form has served the cluster well. The town has an attractive, vibrant centre, and a mix of old and new workspaces, which suited the games professionals. The workspaces are often without car parking spaces, which fits in with the values of the relatively young employment force. Also, unusually for its size, the town boasts a relatively large number of small office units, which suits this particularly entrepreneurial community. Almost 40% of the town centre office stock is found in suites and buildings of less than 10,000 sq. ft (Guildford Borough Employment Land Assessment Appendices, July 2010; Lambert Smith Hampton 2017 Market report). Due to the lack of tenant interest from alternative sectors, the town centre games companies have formed something of a monopolistic market for this distinguished collection of workspaces. According to local agents, this led to a situation where the landlords have had to bend to the games companies' needs, accommodating to their urban/gritty fit-outs and also lease negotiations. Due to the risky and volatile nature of these companies, they almost never signed up to standard leases,[18] taking only short leases. Guildford office agents were accustomed to this need and were well aware which landlords would entertain what were sometimes perceived as more risky and troublesome tenants. One agent said, "There are some landlords I would simply not introduce a games company to."

Respondents did complain about traffic congestion and availability of suitable workspaces, which reflects some of the commonly attributed negative aspects of clusters (Martin and Sunley, 2003). However, contrary to these studies, the issue of raised rental levels was not cited as being a major problem. This seems to be caused by the lack of competition from other sectors for the town centre workplaces. Rental levels are a relative phenomenon, and reflect the level of homogeneity of local property markets at a particular time (Evans, 2004).

Whilst other town centres have been losing workspaces to residential use through the implementation of the permitted development rights from 2015 (described in Section 2.4.2.2), the effect has been slower in Guildford due to control afforded by the conservation area and listed building policies which seek to protect the integrity of these buildings.

[18] A standard lease is generally considered to a be a five-year fully repairing and insuring (FRI) lease, as set out in the Landlord and Tenant Acts. The tenant is liable for all maintenance, insurance, and health and safety costs.

These observations reflect the outputs of He and Gebhardt's (2013) study of creative clusters in Shanghai, where the Chinese government saw fit to protect the historical buildings, identifying them as "creative parks" which were supported by planning policies to encourage their use by creative industries. Whilst in China the intervention was a proactive economic development strategy, in Guildford it was more of a happy accident, with a niche industry's work place preferences aligning with conservationist ideals. Similarly the semi-industrial buildings in Walnut Tree Close, so ideally located near the station and the town centre, were serendipitously saved to the benefit of the industry, due to flood protection policies.

The games cluster is distinguishable due to a combination of historical association with some of the bestselling games in the world, and a critical mass of companies of global industry status (for example, Bull Frog Games, Media Molecule, Hello Games, Supermassive, Criterion, and Born Ready Games). This type of heightened place identity associated with specific clusters has been written about in very few studies (for example, Nathan et al., 2018) in respect of ICT Games and Tech City), so these observations may serve well as a preliminary springboard for future work. Not only is this attractive to the much sort after talent as discussed, it is attractive in terms of giving the firms recognition on a competitive global market stage. As one games interviewee said,

> *When you're in a meeting with companies from China, Korea or wherever, they'll recognise the name Guildford, which is amazing given that we're quite a provincial town and there's not a lot going on here. They might not know exactly where it is in the world, but it does get recognition.*

Overall, the Guildford games cluster had achieved both critical mass and brand status recognition, to support its continued development and override any negative effects of agglomeration. The built environment was central to this achievement, being complementary to the business needs of this risky niche sector.

4.2.2 The London games cluster

London games companies differ from those in Guildford, in that their focus tends to be on games for mobile phones, (see Table 3.13 for a cross-section of games companies by type), often partnered as explained in Section 3.3.2 with publishers and other media related companies, many of which are based in London. It seems likely that the cluster established itself later than the Guildford case, in line with the subsequent development of mobile technology (Section 3.3.2).

Figure 4.7 Central Clerkenwell

Source: Wikipedia https://en.wikipedia.org/wiki/Clerkenwell

According to the UK Games Map (Mateos-Garcia et al., 2014, 2016), there are some 563 "games" companies listed in the Greater London region, albeit fifty-one are to be found in central London, with the main concentration of firms in the EC1 postcode area (thirteen companies), which includes the area known as Clerkenwell, as shown in the density map in Figure 4.8 below.

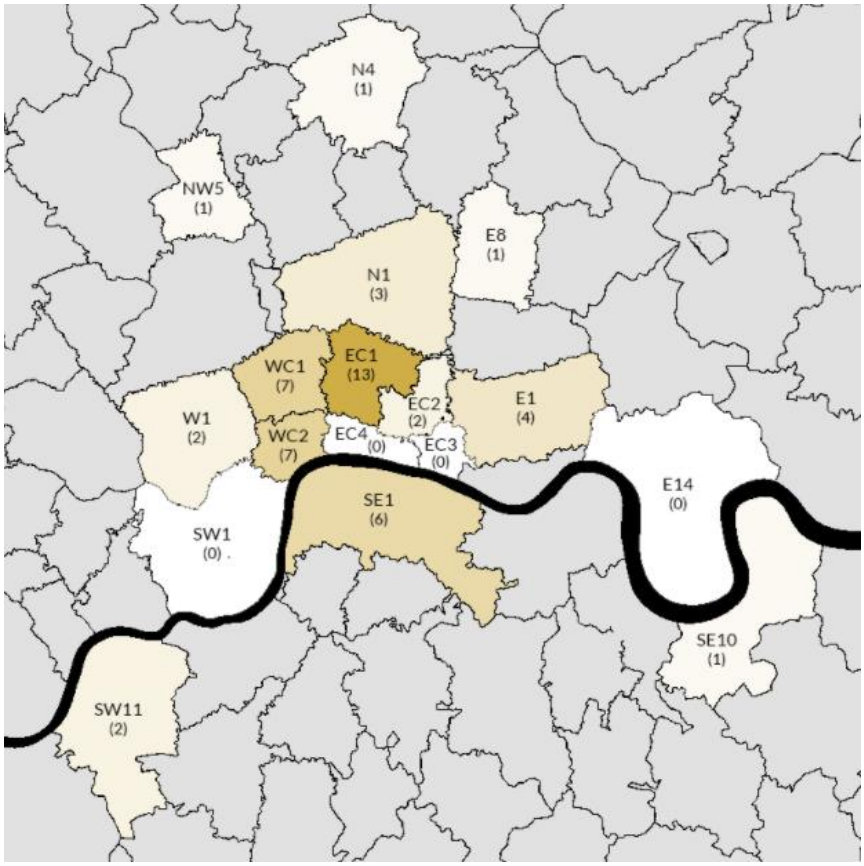


Figure 4.8 Digital games companies in central London by postal district

Source: Mateos-Garcia et al., 2014, 2016

The evidence suggests that, unlike for the Guildford companies, business growth for the London companies tends to be more incremental. The risks are mitigated through their partnership arrangements with publishers and media companies. Start-ups, as in Guildford, were nurtured through home working; however, unlike Guildford, with growth it appears that some companies continued to work from home and remotely due to the higher costs associated with property and commuting. Two of the interviewed companies had made this decision. However, for others, it did not work. As one CEO said:

> *After two years, each one of us went stir crazy in our respective homes. But we needed to expand, size was a limitation on what we could produce. So we shared with a photographer – I think it was a friend of a friend.*

The popular destination for these companies seems to the EC1 post code, focused on the Clerkenwell area. The Clerkenwell games cluster is shown in Figure 4.9:

	Games company
	Railway station
	Conservation area
	Listed building

Figure 4.9 Location of games firms in the Clerkenwell area.

Source: author

The reason for this appears to be a combination of the area's association with the publishing and printing industry; the historical built form, the availability of relatively cheap workspaces in the associated old printing works (Figure 4.10), and the association with the lively creative hub, of Hoxton Square (figure 4.11), which tech, media and games companies seem particularly attracted to.[19]

Figure 4.10 Converted former printing works in Clerkenwell

Source: author

This historical and associational legacy of the area was important to the interviewees. One Clerkenwell based entrepreneur said:

> *I guess that we are very similar to advertising agencies in our model and how that we would seek to manage ourselves in terms of our perception. Now, advertising agencies like to have a portfolio of clients, they like to be perceived in a certain kind of way and perceived to be in the kind of more premium, interesting areas like this area. It's got more diversity, and if you like, perceived creativity, or though actually they're all tech start-ups, which are, or were creative businesses.*

This observation fits with those of Clare (2013), who explored the sense of place of the advertising industry based in Soho and Clerkenwell, and Hutton (2008), who researched the locational preferences of the games industry in London.

[19] Hoxton Square (shown in Figure 4.11) is said to be one of the oldest squares in London. It has been a centre for nonconformist religions, arts and music. From the 1990s it has been recognised as the national hub for (digital and design) arts and media. (Source: Wikipedia).

Figure 4.11 Hoxton Square

Source: Theguardian.com

Many of the interviewees referred to the historical and cultural appeal of the district, citing the vibe, and the numerous bars and restaurants, all of which combined as part of an image that they wanted to project, especially to employees. One young micro-company director said that the area was "kind of cool and aspirational to them [employees]", whilst the director of a media-related company explained that the area had a credibility that was important to them:

> *So the person that's based in Soho, or Clerkenwell or New York, or San Francisco or kind of Los Angeles would be, you know, perceived to be better because of their location.*

Nevertheless, there was little evidence of recognition of a games cluster as such. As pointed out by a freelancer, "It would be nice if the area was known, as you know, a place like Guildford is awash with other developers. So therefore, that helps with [a] talent point of view." Clerkenwell is also the home of UKIE, the trade body for the UK Games and Interactive Entertainment Industry, representing independent game companies. It is a very proactive organisation, which undertakes research on behalf of the industry, lobbies the government, entertains investors, hosts networking events, and provides workspaces for members. Several games companies recognised it as a local asset, which helped start to create the emblematic value of place that they seek.

The light industrial buildings of Clerkenwell offered the cost-sensitive games companies access to expansive, interesting space, which they were attracted to. As described by one agent, the trend was for landlords not to finish off these spaces with expensive fit-outs, but to leave it to tenants who were keen to build their own "urban" image, just as the Guildford firms had done. Some of the older buildings, as was found in Guildford, had less than ideal spaces which the games companies were happy to utilise. Three games companies in the survey, sharing a former printing

works, made the most of both unconventionally low and extremely high ceiling heights (Figures 4.12 and 4.13), utilising them as characterful studio and meeting space.

Figure 4.12 Low ceiling heights of games company workspace

Source: author

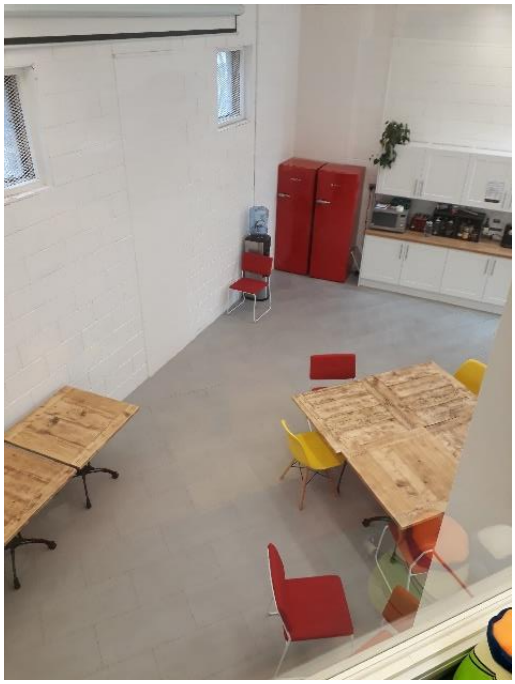


Figure 4.13 High ceilings in games company workplace

Source: author

As in the case of Guildford, the historical heritage and built forms have served this developing cluster well, at least at the early stage of company growth. Similarly, the built form has been serendipitously protected through planning policy. Much of Clerkenwell is protected by planning

policy, conservation area status (see Figure 4.9), and the CAZ[20] London Plan designation, which amongst other things, protects business uses from conversion to residential uses.

Like Guildford, Clerkenwell was also found to be popular because of its transport connections. The marketing director of a medium sized games enterprise said:

> *In terms of geography, I think it's transport that is the vital infrastructure for us, trains in particular, as the rail network feeding London allows talent who cannot afford to live in London to work here. So close access to the right rail stations is probably the single most important thing for us.*

Clerkenwell has easy access to both London Kings Cross and Farringdon Stations, with Cross Rail promised, and current good rail connections to the north and south of London, including to Gatwick and Luton airports and underground lines.

For maturing firms, as in Guildford and reflecting Pratt's (2011) observations, there was a suggestion that secrecy would become a locational issue. A media production company based in Clerkenwell explained how, if they were a pure gaming company rather than a mixed games-related marketing agency, they "would probably want to locate somewhere which is a little bit more like an island". The subject of levels of local face-to-face interactivity is developed in Chapter 5.

At the time of the survey, however, Clerkenwell did not provide all the solutions for a growing games cluster. Whilst firms expand more incrementally, the very competitive market for workspaces meant that these firms were struggling to find appropriate available space at a price that they could afford. Three companies explained how they had to move away from EC1, to the bordering postcodes of SE1 and N1, as they expanded and sought larger workspaces with lower property overheads. An important motivation for these moves were the lower rental values which enabled the companies to do their own fit-outs and stamp their identities on their workspaces. One SE1-based company, which relocated from the Clerkenwell area, described their search for premises befitting their next stage of development:

> *We've been here, two and a half years now… we looked at places in Clerkenwell and Shoreditch, but nothing was quite right… and then we ended up finding this place down here through like a friend of a friend… so for us it became obvious that we couldn't do something that was too "new build" and "too corporate", we needed to*

[20] Central Activities Zone. Office space is protected from conversion to residential space under permitted development rights.

> *bring the rent price down because we knew we were ging to have to spend a lot of money on renovating the space and put like cash up front… the rent was about two thirds of what it was in Shoreditch… I think we spent about* [£150,000] *on renovating the space, like, it was an expensive renovation, but it was because we wanted the vibe. We wanted to have these different kinds of areas that people can work at and stuff.*

The three company CEO's were positive about their new locations and appeared to have few regrets, as they had secured attractive office spaces, and locations with good transport links. However, they all mentioned that they missed the vibe and cultural atmosphere of EC1, and one admitted that the move had contributed to increased staff turnover rates, staff seemingly felt less settled in the new location.

Clerkenwell also contrasts with Guildford in terms of critical mass and historical association. It was the "London effect" rather than the "Clerkenwell effect" that was mainly used to attract staff. Several interviewees reinforced this observation, noting the associated reliance on millennials for talent:

> *Today, it's really hard to convince somebody from Barcelona* [to] *come to Leamington Spa, but you can do it for London.* (CEO, mature games company)

and

> *The London effect is huge for us, because the majority of our staff are under thirty, some under twenty-five. So, I mean, it's easy to get them to come to London, of course, isn't it?* (Marketing director, small company)

In summary, the working practices and characteristics of the mainly mobile phone games firms of London differed from the indie developers of Guildford, in that they were less volatile and less reliant on large teams of individuals. As in the example of Guildford, co-location was supported by the availability of both an emblematic built form strongly associated with Clerkenwell, and nearby transport connectivity. As in Guildford, the workspaces were protected by conservation area policies. Whilst enjoying the "feel good" factor of Clerkenwell, as reflected in Pratt's (2011) study of the area, the exploration unearths a mixed relationship with place and built form, with firms strongly identifying with the media cluster. This weaker association with place is interesting, with some indication that a greater degree of place-based association for the niche sector would help their cause with employment. A follow up study of London-based clusters would be useful to further illuminate these nuanced differences between niche sector industry associations with place, and global city status.

4.2.3 The London cybersecurity cluster

The third case study is the cybersecurity industry of London. London is fast becoming a global hub for cybersecurity firms (Burgess 2017). The cluster has been developing since the 1990s at a time when the key development companies were based in the US and Israel, but London was seen as a large market, well positioned with regard to time zones, and with good European and global connectivity. The key reason for being in London has undeniably been access to this market. As a CEO of a solely British company said,

> *London is a phenomenally unique market in the way you can literally have an office in Waterloo and walk to customers in the City, you can get to stock exchanges, you can go to telcos, you can go to government. And there's almost nowhere else in the planet where you can do that. We work a lot in Washington and everywhere's a two-hour drive. And so, you don't have that benefit. Even in New York, you're predominantly looking at law firms and banking service companies. So, London is really quite special.*

There is no definitive listing of cybersecurity companies, but drawing on addresses found in a major cybersecurity event guide, the postcode locations of London firms have been consolidated in Figure 4.14. The largest concentration of cybersecurity companies (eighteen) was found in and around the EC2 postal district, which is home to the area known as Shoreditch.

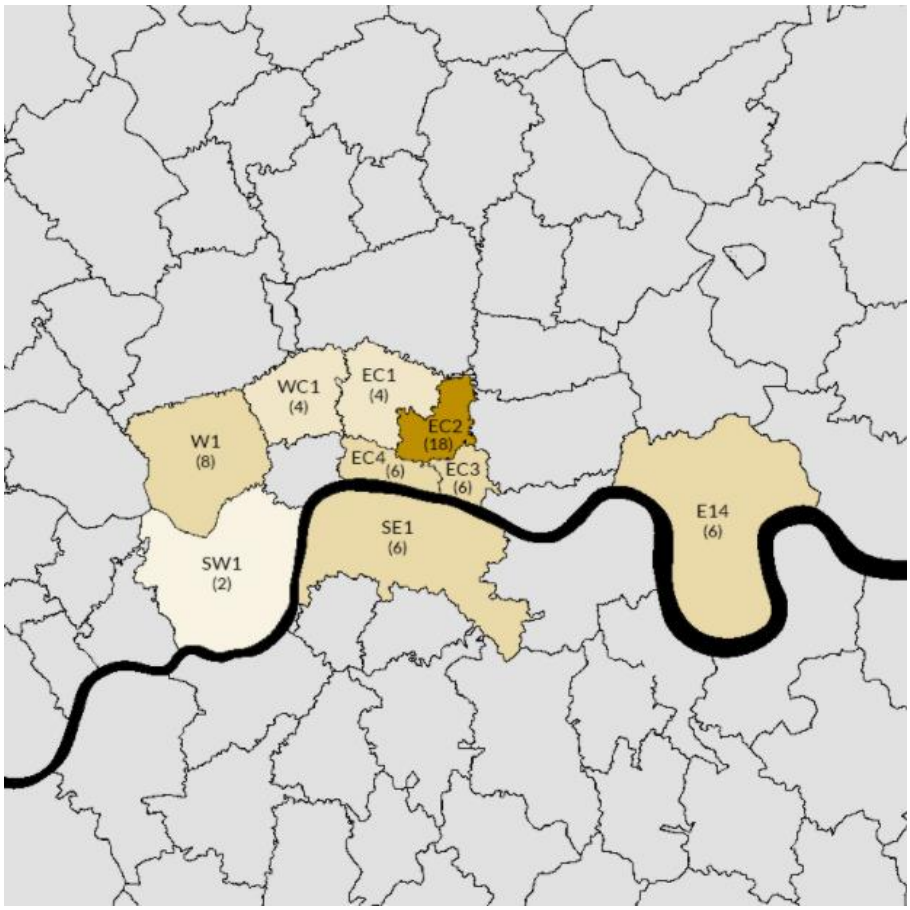


Figure 4.14 Density map of cybersecurity companies in central London by postal district

Data source: Infosecurity Europe Event Guide, 2019

Figure 4.15 Silicon Roundabout

Source: author

Shoreditch is part of the Tech City and Silicon Roundabout area[21] which seemed to suit the cybersecurity community particularly well, very much fitting in with the understanding of the customer proximity needs of software companies (Isaakson, 2004) and the general business model for tech businesses in the area described especially in work by Nathan and Vandore (2014). The area is highlighted in the map below:

Figure 4.16 Tech City

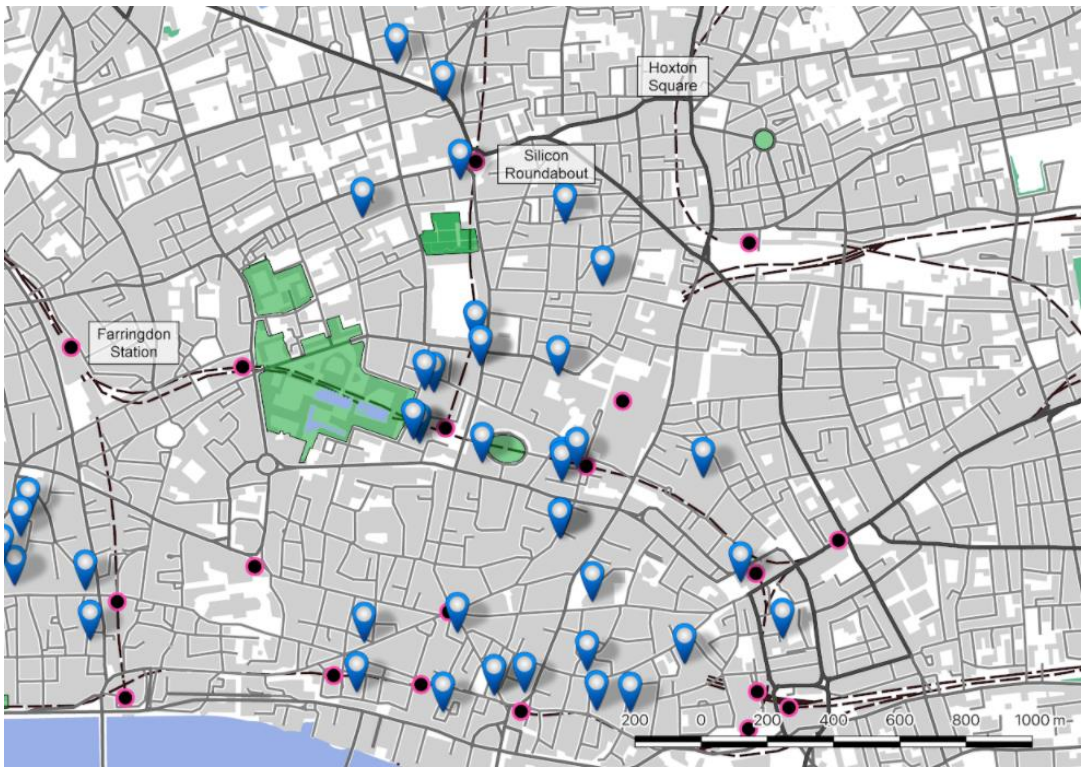
Source: James Wheare's Google map of Tech City, https://www.flickr.com/photos/philgyford/5547336659

According to Nathan (2015), this City fringe area was recognised as suiting digital companies in general because of the associated vibrancy of the area, but he also notes how the emerging fintech niche sector developed there because of the proximity to the City. Cybersecurity seemed to follow the same pattern: being very much reliant on proximity to City-based customers. A CEO of a larger company explained that

> *the majority of cyber will base themselves from Canary Wharf or the City of London. I can't think off the top of my head if there's any who are West End based. Your biggest customers and best customers will always be banks and financial services and insurance sectors, because they are holding a lot of money and have stringent requirements for security.*

[21] Tech City was a government branding and policy initiative launched in 2010, which sought to support the tech cluster based around Old Street and Silicon Roundabout.

The Shoreditch based cybersecurity cluster at the time of the survey has been mapped in Figure 4.17.



	Cybersecurity company
	Railway station

Figure 4.17 Cybersecurity companies in the Shoreditch area

Source: Google Maps and Info security Event Guide 2019

The companies like the "vibe" of the area, and the relatively low rents. The same CEO went on to say that they also located there

> *because it was quite a good area of town… in terms of being close to Old Street,*[22] *essentially between Shoreditch and the City of London… I think it is very price based, we chose it as we wanted to be close to the City.*

The area was also appealing for its good transportation connectivity, which like for the London games companies was good for commuting staff – but especially so as cybersecurity companies

[22] Old Street is recognised as being a centre of the Tech City area around Silicon Roundabout.

worked primarily with remote teams who were out of the office maybe four days a week. One such company CEO said:

> *There are even the remote teams, you know, if they're going to meet up, they're going to meet in London, it's just* [a] *very easy, accessible place. So, by us being here, it gives us a lot more ready-made access for when they are in town. It just makes things a little easier, more centralised to meet up.*

Many cybersecurity companies simply based their agents in London, while their development teams were elsewhere. A US multinational cyber reseller, which had established itself in London in the last ten years, claimed that London was too expensive for an office. They based their UK staff in Reading and had a small space with eight desks in London – a flexible working space with an EC2 address. As they said, they only needed a space for their vendors who mostly worked remotely, "kind of hotelling". Other companies had their marketing offices in London and their development hubs overseas (Eastern Europe, Israel, US) or elsewhere in the UK: Birmingham, Nottingham, Cardiff and Glasgow were all cited.

An examination of the Shoreditch cybersecurity companies workspace suggests that the firms made good use of the many flexible workspaces that had been developed in the locality. Shoreditch, like Clerkenwell, has historically had an industrial past, and there were many semi-industrial buildings and blocks which could be easily converted to contemporary flexible workspaces. Furthermore, there are fewer conservation areas and listed buildings than in Clerkenwell, (as shown in Figure 4.9), which meant that some could be torn down and new, more streamlined spaces, enjoyed by the cybersecurity firms, put up in their place. Figure 4.19 also differentiates between cybersecurity companies based in flexible working spaces with those that are in individually tenanted space. It would appear that there is a relationship between the lower density of protected buildings and the workspace preferences with the development of the cluster. A thorough spatial analysis of flexible working space development would help to inform this observation.

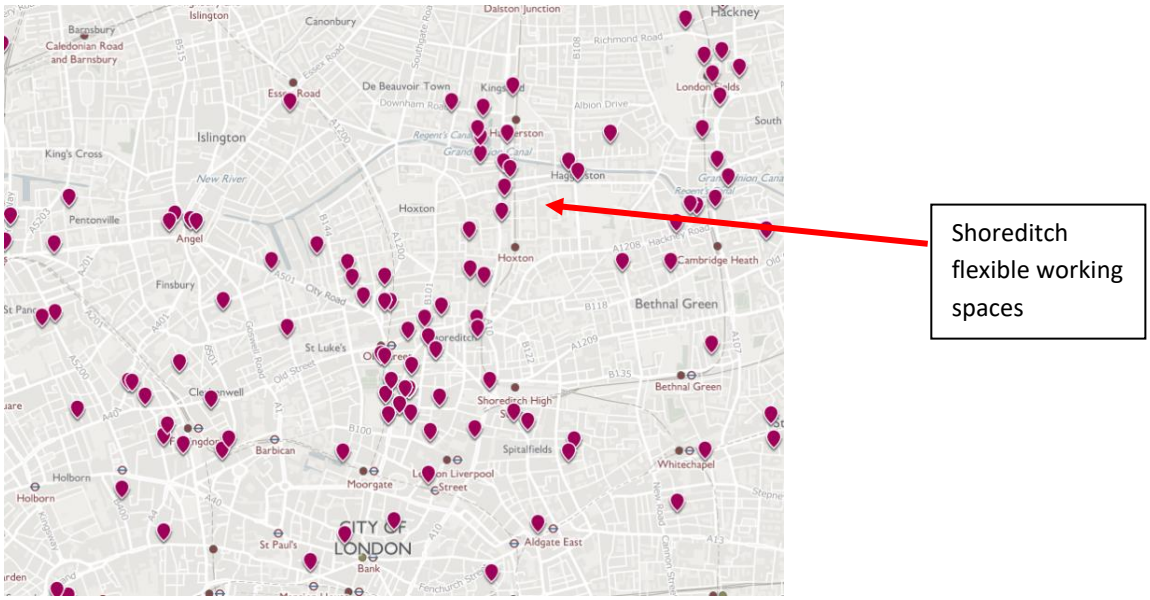
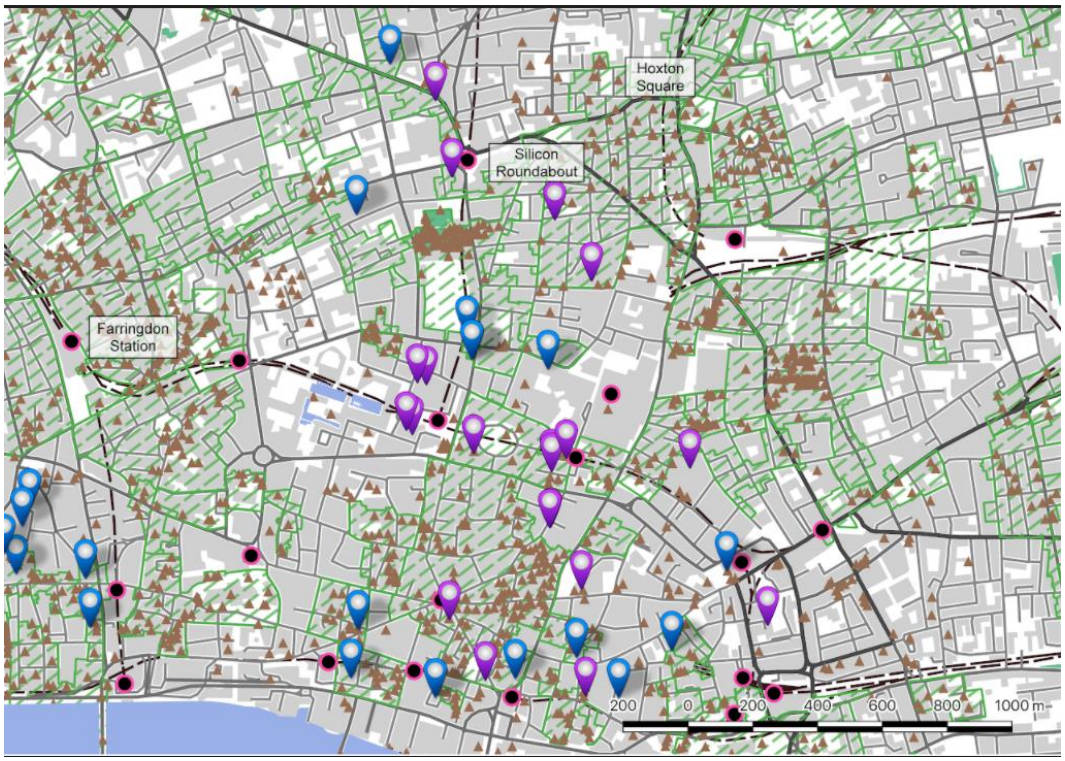


Figure 4.18 Flexible workspaces north of London

Source: Google Maps



	Cybersecurity company occupying private workspace
	Cybersecurity company occupying flexible working space
	Railway or underground station
	Conservation area
	Listed building

Figure 4.19 Map of London cybersecurity companies in the Shoreditch area by accommodation type

Source: Google Maps and Info Security Event Guide 2019

Interestingly, the rise of these spaces has been well documented in terms of supporting creative industries (for example Spinuzzi, 2012 and Merkel, 2015). This exploration can add some insights in terms of more technical niche sectors. These spaces provide an ideal flexible working model which suited the working practices of servicing cybersecurity firms, which, often, were working in their clients' spaces, and doing their development work overseas or in other parts of the UK. The interviewed companies based in the flexible spaces found them to be useful as a starting point for penetrating the London market and not taking on the risk of a standard lease contract. Costs relate simply to an "all in per desk" payment. The flexibility of the spaces meant that they could add or subtract a desk on an almost daily basis.

Figure 4.20 Inside a Shoreditch flexible working space

Source: London Resident Magazine

Many of these flexible workspaces are not ideal for growing companies. One US-based multinational vendor described how there was a limit to how long they were prepared to stay in shared workspace, because of the high noise levels and lack of privacy: “It did the job for a while. We had our own office for a while. There was a coffee machine, and beer on tap. But the novelty wears off, and we wanted a bit more space.” The next stage in the cybersecurity workspace supply pipeline is far from clear. Two companies expressed a desire to move just outside Shoreditch to the Finsbury area where they could get a lower rent and “create their own funky identity”.

The largest cyber-related company in the interview survey, a UK organisation undertaking joint management training and vendor and recruitment activities, had had their own office space for as long as the vendor interviewee could remember. Despite the vendors being mainly remote workers, the other activities of the business relied on clients coming to the office both for meetings and for training activities. They needed to present a certain “face” to the clients, and with office space requirements becoming greater, they were moving out of Shoreditch – probably to a neighbouring but slightly more peripheral workplace. Like the expanding games companies, their aim was to get a larger space at lower cost. They wanted to put their own “funky” design stamp on the new offices. The industry is changing and with it its culture, as will be developed in the next chapter. The growth of the less sensitive mobile and PC-based projects, from government and company cybersecurity, has translated, as a freelancer explained, into a change of workspace locational strategy. Businesses are becoming more interested in creating “a culture that people enjoy working in”.

The co-location of London cybersecurity companies appears to be based on the availability of preferred flexible working space in an area close to their customer base, which is supported by good transportation connections and an attractive, vibrant area. There was evidence of some association with the tech quarter. A cyber recruitment professional described the cachet associated with an office in the Old Street area:

> *Because it's a tech hub which goes hand in hand with doing business… it's not like people have like a walk-in relationship with us as a recruitment firm. I think it's just good to have that postcode and that sort of like "Okay, these guys are based in central London offices there. They're not just based in the middle of nowhere", sort of thing.*

The cybersecurity firms like the London games firms appear to rely on "the London factor" to project an identity. The industry relies on a very niche skillset, and being in London did have a draw for young professionals in the same way as it did for the games companies. When asked if they struggled to find skilled staff, a CEO said, "yes, a bit," and

> *Post-Brexit, it's got a lot worse. 50% of our staff were EU born non-Brits, so that's been painful. We outsource a bit more, let's say you outsource to some Eastern European country. You're now competing with Silicon Valley for those developers. So suddenly, they can be almost more expensive in London wages. You've got a global phenomenon happening.*

So London cybersecurity firms compete on a world market for their staff. The high cost of these professionals also reinforced their demand for small, flexible workspaces, because it was largely too expensive to operate their development operations in the city. Unlike the games firms, some cybersecurity firms felt that their value chain was better balanced by luring the specialist development talent to cheaper, more provincial UK cities , simply keeping the marketing offices in London. A cyber vendor explained how the high salaries dictated by the technical specialists in the business affected the location of the sector:

> *You have to remember that cyber is very, very limited by the amount of people that understand the level that is needed. So it's a lot to do with the ability to find the right people which enables you to grow your company. I mean, some of these salaries can be pretty "eye watering" as well. So if you can set yourself up in a place like Cardiff, you're not in the same sort of market rates as London and you have access to the same amount of people for significantly cheaper. As long as they've got communication into London, they'll be fine.*

Another factor for basing the developmental operations away from London is security, London being perceived to be a very insecure location for some of these activities. One company in the survey had its "safe zone" where they did "penetration testing"[23] in Nottingham. This supply-chain locational characteristic of UK cybersecurity firms is picked up again in the final case study in Malvern.

The kudos associated with a location in London was such that even a start-up company working remotely felt that they must have a registered address in London. There were numerous companies offering "prestigious addresses" in W1, WC1 and EC1 from £35 per annum. They provided a postal address and mail forwarding service, plus other services including telephone receptionist and call forwarding services. Two interviewees, both independent entrepreneurs working remotely, simply opened a registered address in London. A Bulgarian security reseller explained how many IT consultants and vendors were now based in Eastern Europe and could work remotely. They did, however, need the London registered address. Thus, whilst there were numerous cybersecurity-related firms in London, it seems likely that a good proportion of those, especially with a central W1 address, were simply a registered address, not providing space for workers, but still facilitating access to the lucrative London markets of the interview group.

Overall, the London cybersecurity companies differed from game firms in that they were supply chain–led, and many of the professionals were vendors and service agents. Co-location in Shoreditch appeared to be mainly about the availability of their preferred flexible workspaces which had grown up contemporaneously in the Shoreditch area and which provided well-connected flexibility, relatively cheap and functional workspace, and proximity to many of their clients in the City of London. These observations are novel and developed in more detail in Chapter 5. Cybersecurity firms particularly struggled with their very niche skills requirements and the associated very high salary rates. This has led to many firms maintaining their development functions in the rest of the country, adding nuance to Florida's possibly over generalist observations regarding the "youthification" trends of large cities. (Florida, 2018). Observations relating to the reliance of place to project the cluster's identity are similarly more to do with the "London factor" and, in this case, an association with Tech City in general. Again it is seen, perhaps for the first time, that niche sectors in a global city have a more complex relationship with location when it comes to their place branding efforts.

[23] Legal testing of company information systems security.

4.2.4 The Malvern cybersecurity cluster

Figure 4.21 The spa town of Malvern

Source: Wikipedia https://en.wikipedia.org/wiki/North_Hill,_Malvern

In contrast to the more urbanised case studies of Guildford and London, Malvern is a town of some 30,000 inhabitants (2011 census), situated adjacent to the striking Malvern Hills. It has an attractive, historic town centre which grew as a spa town and prospered because of tourism. Malvern is said to be home to one of the largest centres of home-working professionals in the country, and host to 7,287 digital jobs (Tech City, 2017), the highest concentration in the country.

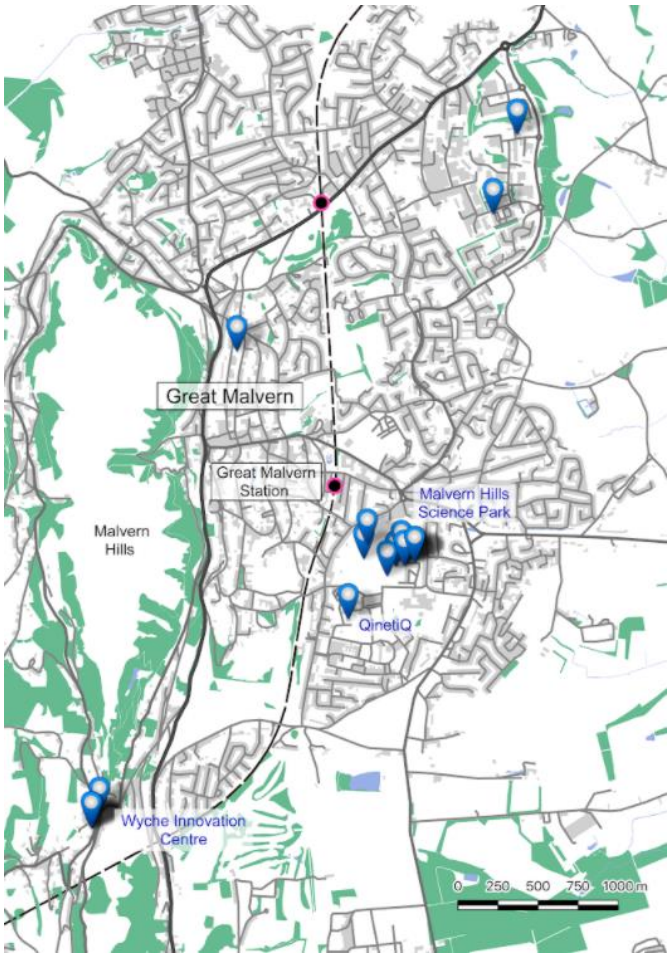
Figure 4.22 The site of QinetiQ and the Malvern Hills Science Park

Source: https://en.wikipedia.org/wiki/Malvern,_Worcestershire

Many of those professionals are working with or have worked for QinetiQ, staying in Malvern because, as one new start-up said, it provides a “nice environment and quality of life”.

Cybersecurity development work can often be undertaken by a lone consultant. As the CEO of a new start-up said: “A lot of people are out by themselves. There’s a lot of money in finding bugs in

other people's software programmes." Clearly this is work that will continue to grow, and Malvern's bedrock of technological skills has been fertile ground for business start-ups. Tech Nation (2017) describes how there were seventy-two new technical start-ups in Malvern/Worcester between 2011 and 2015, one of the highest growth rates in the country. The UK Information Economy Strategy Report (2013) says there were between fifty and a hundred businesses based around Malvern and that it is "one of the primary locations in the UK for the research, development and commercialisation of cyber security product and services". The National Science and Innovation Audit (2019: 15), says that Malvern "now holds the UK's largest cluster of cyber security firms". Their location at the time of the study is shown in Figure 4.23.



	Cybersecurity company
	Railway or underground station

Figure 4.23 The location of cybersecurity businesses in Malvern

Source: author

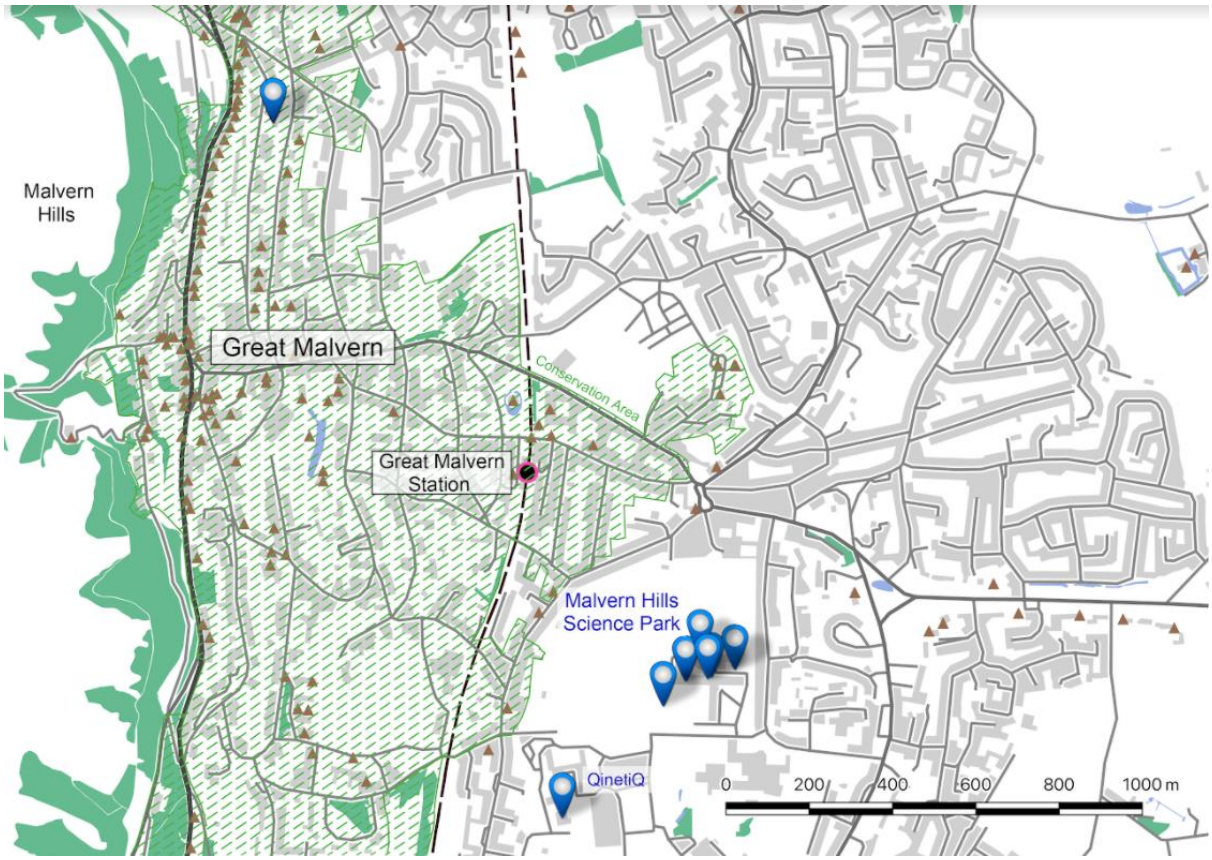
Some of the home-based workers in the country, some of these move on to the Wyche Innovation Centre (Figure 4.24), which, like Rocketdesk in Guildford, provides niche sector–orientated flexible workspace for micro-enterprises.

Figure 4.24 The Wyche Innovation Centre

Source: http://www.igenceradar.com

The centre is located two kilometres south of the town centre, and although it is slightly remote, according to one enthusiastic tenant it provided a “no frills, low cost, no tie in” space, a “combination of both open and cellular space”. As another said, the “price is affordable, and we liked the type of space. It is informal but gives the right impression”. The tenants seemed to enjoy the rural aspects of the space, the hot-desking facilities, and a cafeteria.

Thereafter the natural progression seemed to be to relocate to the Malvern Hills Science Park, which is 1.5 kilometres east of the town centre, beyond the historic and protected buildings of the town centre, as shown in Figure 4.25.



	Cybersecurity company
	Railway or underground station
	Conservation area
	Listed building

Figure 4.25 The location of cybersecurity businesses in central Malvern

Source: author

The tenants enjoyed the modern, open and relatively cheap office space with negotiable short leases, and easy car parking. The Science Park was one of very few developments in the area providing this type of space, and it is no coincidence that few cybersecurity businesses were found elsewhere in Malvern. The Science Park was the home of some eleven cybersecurity companies. A CEO of one small business described their search criteria vividly: “We wanted to move from home into some office space and really struggled to find something that was not Victorian and pokey. ”His “work force want a small tidy office, not funky. Table football is a bit passé”. The Science Park provided them with their only option. QinetiQ, in partnership with local councils, built the Malvern Science Park on land owned by the company, at a time when they were privatising and wanted to spin off companies which were encouraged to take advantage of numerous intellectual property rights. The Science Park immediately became the home of a spill-out start-up cybersecurity community. It was soon full, and to satisfy the demand for workspace, two cyber entrepreneurs set up the aforementioned Wyche Innovation Centre. The centre, which

also organised the “Cyber Security Cluster” networking forum, became something of a conspicuous hub for the niche sector community.

Figure 4.26 Malvern Science Park

Source: http://wlep.co.uk

As found in the other case studies, two of the more established companies in the survey also demonstrated a desire to move on from the Science Park into spaces in which they could “stamp their own image”. These observations suggest that the desire to project a strong physical image through building environment is not simply the domain of games companies as described by researchers such as Pratt (2011). One company, reacting to the functional contemporary look of the Science Park, pointed out that it is not conducive to the creativity needs of the cybersecurity sector, saying, “It is a place of implementation, it’s a place where you house engineers and scientists to go and do their thing”. He likened it to a university campus, but without the cultural facilities to “drive up the creative juices”. So whilst superficially cybersecurity companies said they wanted the clean lines of the Science Park, it could be that inability to stamp their own identities on the workspaces had a limiting effect on creativity, which is clearly is essential for *all* development-type businesses. These observations add to an emerging literature on the curation and encouragement of creativity in the workplace (for example Merkel and Suwala, 2015; Brinkoff et al. 2015; Bhaskar, 2016), suggesting that more can be done in terms of the design of workspaces for the more technologically niche sectors, since they too, as they mature, seem to want to create their own individualised spaces. The largest company in the survey had bought its

own freehold space, which enabled it to cast its own stamp on the space. Notably the employees were given three choices for the fit-out, and chose the "urban gritty" look which the games companies were associated with. Following the same pattern as the larger London games companies, this CEO explained his locational preferences:

> *So, at the time we were looking, because we wanted to improve our environment and we needed more space. And we were looking at a longer-term contract because we were going to be putting a lot of money into improving the environment. I know it sounds crazy but it's really important to create a space that people want to be in and they're comfortable and happy, so we were willing to make that commitment.*

Firms complained of two main constraints in their built environment, workspace availability and transport connectivity, both of which could have a damaging effect on cluster evolution. Workspace availability is explored in detail in Chapter 6. The limitations of transport connectivity is at least as important. Cybersecurity firms are reliant on access to clients. The surveyed firms expressed their frustration about connectivity and bad roads, including access to train stations, and the slowness of train services to key market destinations such as Birmingham and London, and thence via international airports to overseas. Many firms had strong links with overseas organisations, especially in the US and Israel, and visits were necessary. As a CEO of a larger firm said, "The big problem here… I mean it's connectivity. You know it's a three-hour trip to London and you take out a second mortgage because that's is how much a ticket is going to cost you." The limitations of rail connectivity in the region have been recognised by the authorities, who are providing a new train station, Worcester Parkway. However the station, which is on the east side of Worcester, did not "cut much weight" with the Malvern-based interviewees.

Despite these frustrations, the cluster appeared to be sustainable. There was no evidence of firms closing, nor relocating out of the areas. It seems that they recognised the advantages associated with the town's historical association with the cybersecurity industry in the area. Malvern was central to what has been coined, the "cybersecurity valley", a triangle including Cheltenham, Hereford and Worcester, as well as the home of QinetiQ, the privatised cybersecurity and defence operation, previously the Government's telecommunications research centre, which moved to the town during the Second World War. The region, stretching from Bristol to the West Midlands, has developed a global status for cybersecurity and defence, and Great Malvern is centrally placed within it, a fact not lost on the interviewees when describing the advantages of the town from a business perspective. A micro-enterprise described how "the area is quite spread out… I think for having a central location, Malvern ticks the box."

The built environment plays a central role in this spatial imagery, with the Malvern Science Park recognised as being synonymous with the UK cybersecurity industry. Undoubtedly this branding was added to by the development of the Wyche Innovation Centre, and its associated clustering initiative and industry-focused events. Pierre Audoin Consultants alluded to this in the Competitive Analysis report of the UK Cyber Security Industry:

> *A group of small suppliers, based in the town, collaborate on shared marketing initiatives (such as exhibiting under a shared banner at the InfoSec event) which enables them to punch above their weight in terms of brand awareness.* (Department of Business, Innovation and Skills, 2013: 31)

As one interviewee said, “Malvern is great because it has its branding so it’s got a certain cachet to it which is good, so when your funders know that you have offices in Malvern Hills Science Park, they know you are a serious company.” A further CEO said, “but at least we [Malvern cyber firms] are known. We are on the map which gives you some credibility.”

The Malvern case study demonstrates how the firms were co-locating due to a relatively fertile seed bed for spin out enterprises from an area rich in cybersecurity skills. Not only did the Wyche Innovation Centre and the Malvern Hills Science Park provide appropriate workspace for the growth needs of the firms, but they were also a central part of developing what appears to be a strongly supportive brand image, which has been a common theme throughout these explorations. Even in Malvern which struggled in terms of important transportation connectivity, the kudos and attractiveness of the place itself seemed to outweigh these issues. This is further useful evidence to support some of the emerging work on spatial imagery (for example Klijn et al., 2012; Zenker and Bran, 2017; Nathan et al., 2019). Additionally, insights relating to design features of technological parks add to the literature on the curation of spaces (for example Merkel and Suwala, 2021). The implications of these observations are discussed further in the following consolidating sections.

4.3 Reflections on the outputs

This thematic study has focused on the drivers of niche sector co-location, investigating firm workspace demand patterns, the effects of characteristics of the local built environment, and adaptive firm behaviours to the effects of limited workspace supply.

4.3.1 Firm workspace demand patterns

On consolidation of the case study evidence, whilst variations were apparent, there appear to be three common locational drivers for all the digital technology firms: workspace preferences and their availability, transport connectivity, and workplace imagery and reputation.

Workspace preferences and availability

The interviews showed distinctive building and workspace preferences for each niche sector, reflecting differing working practices. In purely physical terms, the games companies needed more desk space than cybersecurity companies to support their technological hardware requirements and virtual reality work. Digital games firms seemed to have a strong preference for public transport, unlike the cybersecurity professionals, which meant that they had little need for car-parking space. However, by and large, the motivations for taking space related to a keen sense of niche sector association with certain types of building space. In general terms the games companies tended to prefer interesting, often older, offices, which in both case studies had historically been light industrial buildings.

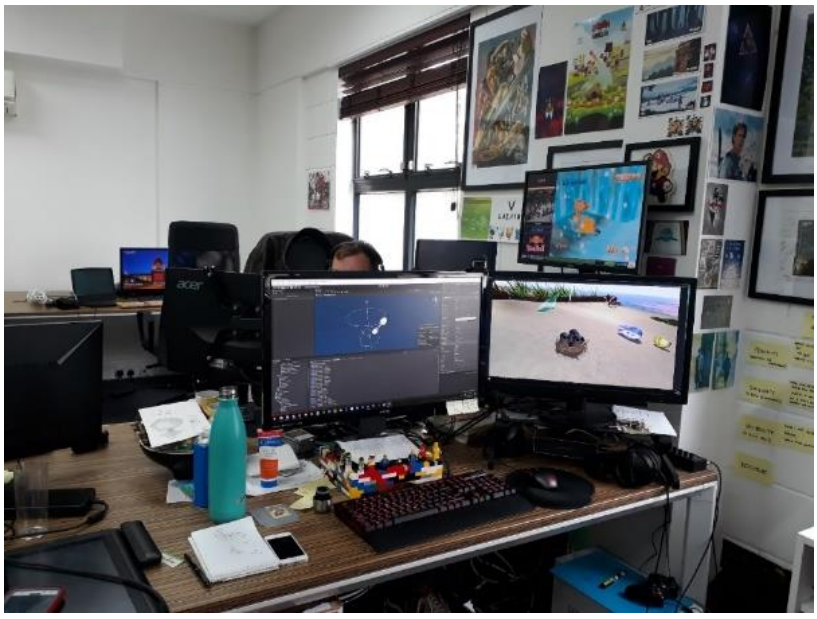


Figure 4.27 Desk space of games professional

Source: author

Figure 4.28 Light industrial building in Clerkenwell, home to several games companies

Source: author

Cybersecurity companies generally preferred modern, functional spaces. The games companies of Guildford consciously avoided locating in the edge of town's science park, preferring the older buildings in the town centre close to the station; and the games companies of Clerkenwell, like in Guildford, seemed to enjoy old industrial space. Conversely, the cybersecurity enterprises in Malvern enjoyed a less distinctive work space, and there was evidence that the Malvern firms were actively avoiding the Victorian-era buildings of the town centre, because of their "pokiness". It is unclear whether these preferences related to the heightened awareness of the client-facing cyber companies to presenting a cleaner, more efficient look, or whether these preferences reflected individual taste.

The built environmental needs for early-stage firms in each case study were satisfied in differing ways. Affordability was key in terms of new businesses moving out of the home base. Guildford and Malvern firms were provided for in bespoke flexible working spaces aimed at these early stage firms. London firms seemed to stay at home for longer, although games firms with their greater spatial and integrative working requirements were forced to move out. Many games firms in both Guildford and London found themselves sharing spaces. Cyber firms were well catered for in both the Malvern Hills Science Park and flexible working spaces in London.

Figure 4.29 The fitted-out workspace of a large games company in London

Source: Hutch Games spacistor.com

Interestingly, as they matured, all firms in both niche sectors showed a desire for more privacy (developed in Chapter 5), more space (developed in Chapter 6) and a strong desire to stamp their own identity on their workspace. The desire to individualise workspace was strong and appeared to be a general property market trend recognised by the interviewed agents in the London City Fringe districts, such that many were advising their landlord clients to let workspaces without final "fit outs" – also reflecting the evidence of Tuuk (2012). The trend has been termed "aestheticization" in the property literature (Guy and Henneberry, 2004: 228), and has been associated to date with the "new cultural entrepreneurs" (Leadbetter and Oakley, 1999), "urban innovators" (Landry, 2000), and the creative sector (Florida, 2002; Pratt, 2000; 2011; Clare, 2013; Champion, 2014). This study is evidence that it is a cluster-locational factor which cannot be overlooked. These probing insights into niche sector workplace preferences, including business life cycle stage, are novel. The implications for cluster development start to become apparent and are developed in the following chapters.

The firms and clusters benefitted from the availability of appropriate and preferred workspace, and it is interesting that in each case the availability was in part due to a lack of planning intervention. In Guildford and Clerkenwell the availability of interesting historic workplaces was due to protective conservation policies; whilst conversely the blossoming of flexible workspaces in Shoreditch, which had benefitted the cybersecurity community, was generally due to the lack of these policies. This non-interventionist stance of the planning authorities is noteworthy and adds to our understanding of the complexities of cluster evolution. The observation will be developed in more detail in Chapter 6. In contrast, the cybersecurity cluster of Malvern benefitted from the

proactive intervention of the building of the Malvern Hills Science Park, which had planning conditions limiting its occupancy to technical firms. Both the Science Park and the development of the Wyche Innovation Centre start-up hub afforded the emergence of the otherwise relatively invisible home-based entrepreneurial community. These insights add evidence and insights into the very small but emerging literature on the role of planning policies in cluster development (Osman, 2015).

Transport connectivity

Transport connectivity was a major topic of conversation for all interviewees in each of the case studies, in the same way as it has been recognised in the classic industrial location literature (McCann and Sheppard, 2003). All the interviewed firms valued proximity to a well-connected train line. The Guildford firms' anxiety to be close to the station seems to reflect both the Manchester study (Champion, 2014) and much of the literature relating to the workplace preferences of millennials (for example McDonald, 2015; Moos, 2013, 2016; and Lee and Lee, 2017), and the ideas stemming from the work by Florida, that knowledge workers of today value "walkability", transportation, and proximity to amenities (Florida, 2002). However, the study evidence shows that the picture is more complex than simply millennial lifestyle preference. The Guildford firms also enjoyed train access to London and its industry support, much in the way that Champion's Manchester-based games firms enjoyed London connectivity (Champion, 2014). The difference in this case is that London firms, in both niche sectors, valued the train service in supporting their commuting lifestyles. Millennials have grown older, and what we might be seeing is their changing lifestyle behaviours. Maybe they have moved away from central city living to a more provincial family lifestyle, as suggested by Brydges and Hracs (2019b).

Train connectivity also mattered for all the firms in Malvern, mainly due to their customer service needs. However, despite the frustrations of both a slow and expensive service, together with congested roads, the firms remained in embedded in the town. The possible negative implications for the property market and cluster growth are explored in Chapter 6.

Workplace imagery and reputation

A third, less tangible factor of workplace reputation was found to be equally as important as workspace availability and transport connectivity. Most interviewees in each of the case studies demonstrated a strong association and identification with place, as well as with the cluster and its reputation. The ingredients of this emblematic driver seemed to be a combination of attractive workplace and pride in a historical association with quality products and the degree of conspicuousness of the cluster – a combination of the number of firms and other industry-

associated elements including local champions, events and institutions. There were observable differences in this effect between the provincial clusters and the London-based clusters. In the case of Malvern and Guildford, location related to the combined recognition of the towns' attractiveness and built form, and their reputation for quality digital niche product development. In both cases there was pride associated with being in the cluster, but also a recognition that this was essential for survival, in terms of attracting and retaining much-needed skilled professionals, and of putting their cluster on the global map. For the games companies, their view of the world seemed defined by the games that had been made in the town, as well as local champions and place branding. Games professionals would say that Guildford is synonymous with Peter Molyneux, the founder of Bullfrog Games. He actively encouraged games professionals to join him in Guildford in the 1970s. A Guardian article (June 2014), described his role in Guildford:

> *It'd be outlandish to describe Molyneux as messianic, were it not so patently true. Not only did he make his fortune creating God games – games like Populous, where players are given supreme powers of influence over entire virtual worlds – but then he re-enacted one for himself using Guildford as the canvas.*

The same article described the games industry in Guildford as the "Hollywood of Games". That label stuck. The Malvern cluster similarly enjoyed being associated with the area's historical cybersecurity legacy, recently reinforced through the town's association with the "Cyber Security Cluster" and promotional work undertaken by the sector's local champion, Emma Philpott MBE. Additionally, not forgetting the built environmental theme of this study, it is observed that not only was built form integral to place image, but both clusters also included distinctive bespoke starting spaces – Rocketdesk in Guildford and the Wyche Innovation Centre in Malvern – which undoubtedly added to cluster identity. Niche-sector built form is clearly integral, and a blended extension of firm branding requirements.

Figure 4.30 Rocketdesk in Guildford

Source: http://www.ofixu.com

The pull of place association and identity is increasingly being understood in the literature, and generally associated with the need to attract talent. Undoubtedly the coining of the name "Silicon Valley" and its associated reputational history have attracted tech firms to the region. Huber (2012b) noted how the IT workers in his Cambridge cluster study felt they needed to be "seen" as part of a larger entity with a global brand. Places have long been associated with product reputational history (for example Italian shoe production and Hollywood movies), but in both cases there was an added dimension, perhaps overlooked in most studies. The success of the branding related to the fact that it was created from within, not by some external economic development professionals. In both Guildford and Malvern, there was a palpable love of the work and being in the associated place. The spatial imagery is largely about projecting this pride to other likeminded professionals, and in both cases it would be difficult to disentangle the association of historical reputation and pride in the quality of output. The skillsets in both towns are extremely niche, and professionals moved in to work on the projects that they are passionate about. A small cybersecurity business CEO, exhorting the virtues of the Malvern cluster, said, "the skillset which we are after, is very, very niche. The work is just phenomenal. This is what it's all about. Malvern and what we are doing is sexy". The idea of supporting a love of work has featured in some of the economic geography literature. Deo (2012), in his study of games, quotes a games CEO and his view of their workspace, which should be a place in which his staff can sustainably make quality games and have a place where they "love to work and create". Bank's 2012 study of the digital games industry in Australia proffered the idea that a workspace should be a place with "a work life balance in which creativity can thrive", and it was his view that games enterprises "may well be at the forefront of such adaptive organisational behaviour". As Massey

(1995), points out, the dominance of males in the technology sectors must be having an impact of their workplace choices and preferences.

Interestingly, neither the Guildford nor the Malvern firms were much enamoured by policy-driven branding efforts. They were dismissive of a "made in Guildford" branding idea that was proposed by the Council, and Malvern firms rarely mentioned the "cyber valley" initiative of the local economic development partnership. Reputation can of course work both ways and is a fickle locational driver, as pointed out by a Guildford entrepreneur:

> *When I first worked here, Guildford had that reputation really strongly as a UK game development hub. I think over the past ten or fifteen years we've really started to lose that a bit. In maybe the last five years that reputation has finally started to come back.*

For London firms, this reputational effect was perhaps more complicated. There is a double layer of association, firstly with London as a global city which attracts the young, mobile professionals, and secondly with locality within London. Neither cluster had developed a distinctive reputational prowess as was the case in Guildford and Malvern, although notably both the non-London examples demonstrated a longer associational history with their respective industries. Moreover, the London clusters, due to their business models, had aligned themselves with the creative and technology sectors of Clerkenwell and Shoreditch respectively, and an association with the "cool" "tech" and "hipster" images that they presented. All the companies, in both niche sectors, described the "London factor" in attracting global footloose talent. These observations add nuance to the work on the "new geography of jobs" (Moretti, 2013) and Florida's work on the global workplace (2018). The cluster with a positive industry-associated reputation is perhaps best placed to attract scarce, globally mobile talent. The point is that these successful clusters were able to generate their own "spatial imaginaries", rather than take advantage of policy formulated interventions, as noted by Nathan et al. (2019). This study recognises the synonymity of workspaces and place which, as far as is known to date, is only recognised in the property press (Watson, 2020: 26). There is also a suggestion that male dominance may influence workplace preferences, something which would need further investigation. Whilst there is extensive research on the locations of the creative industries, showing their preferences for inner-city areas where the historic buildings are regarded as being emblematic of their creativity (for example Hutton, 2004: 40-68; Florida, 2002; He and Gebhardt, 2012), this study is also novel in that it has probed the built environmental requirements of a technologically niche sector, and recognised a similar business-related identity association between place and workspace.

The findings support the Jones Land LaSalle (2016) report that said that, these days, locational decisions are pre-eminently about talent: “positioning real estate to attract and retain the best talent is gaining importance… Driven by demography and lifestyle, immigration and globalisation, working practices, sustainability and accessibility”. The case studies provide strong evidence of the emblematic value of the built environment and its interdependence with attracting both creative talent (as described by Florida, 2002 and He and Gebhardt, 2013), but also the technical businesses of the cybersecurity enterprises which has not hitherto been explored.

4.3.2 The characteristics of the local built environment which have supported co-location.

In each case study, built form has been shown to match the preferences of the niche sector: historic and semi industrial buildings in both Guildford and Clerkenwell to satisfy the games companies, and more functional building space in the Science Park and Wyche Innovation Centre of Malvern, and the flexible working spaces of Shoreditch for the cybersecurity sector. The section explored the needs of each cluster by business life-cycle stage, and found that appropriate workspace was available: cheap flexible space for start-ups and break-out businesses, Walnut Tree Close and the Rocketdesk start-up centre in Guildford, the Wyche Innovation Centre in Malvern, and flexible working spaces in London. “Move-on” space was especially sensitive in all cases, with the larger spaces at affordable rental levels often being at a premium. At this stage the firms exhibited their desire to “cast their own branding”, and an increased sensitivity towards security and privacy. It is shown that the availability of preferred and appropriate workspace by business life-cycle stage is crucial for each cluster to start and develop, and the importance of appropriate “move-on” space cannot be overstated, much as it is acknowledged in very few other studies including Segal Quince Wicksteed (1985). That said, the idea of individualising workspace appears to be a new locational driver, which needs to be added to the mix in terms of industrial location strategy.

The role of the property market and planning policies in delivering or conserving these preferred workplaces has been described, and will be further developed in Chapter 6. Clearly the property market is a dynamic force, such that without protective planning polices, the interesting historic and semi-industrial buildings would not have been saved for these companies. Ironically, the co-operative work spaces occupied by the cybersecurity companies have existed due to their location beyond conservation area zones. The Science Park in Malvern had planning conditions restricting its occupation to technical and scientific uses, rather than allowing the dilution of occupancy, and thereby protected the cluster. The evidence will add nuance to a small but emerging literature on the role of planning policy in cluster development.

Transport connectivity was good in Guildford and London, which according to authors such as Champion (2014) and in my case studies was cited as being important to firms, facilitating commuting lifestyles. However, the Malvern case differed in that, despite clear evidence of an inefficient transport system, firms seemed to put up with the situation, due (it is thought) to a combination of embeddedness in an attractive environment and recognising the credibility of place in supporting their ventures. What is unknown, but should be the subject of further study, is whether the poor transport situation is a disincentive for firms to move into the area, potentially stymying cluster development.

4.3.3 The obstacles to preferred locational preferences and business responses.

The chapter, in recognising the "ebbs and flows" of the workspace property market, shows that in times of short supply and increasing rents, digital business, on the whole, will adopt adaptive behaviours rather than relocate, with the "lure" of place being pre-eminent. New start-ups in both Guildford and Malvern have had access to start-up hubs, both of which were developed by industry champions who identified the need for cheap collaborative space. In London, new games businesses are more likely to work from home, due to higher rental values. Some seemingly London-based cybersecurity companies work remotely from an overseas base, propping up their business credibility by simply buying a London address. Most businesses in the three studies – Guildford, Malvern and Clerkenwell – managed the situation of increasing rentals and shortage of office supply which were associated with a growing cluster. In Malvern, where new office supply was almost negligible (discussed in Chapter 6), digital companies would rather "cram" their staff into the Malvern Hills Science Park than relocate, according to one agent. Young mobile games companies in London really struggle, but clearly the pull of Clerkenwell and its creative associations is worth the high rental values. A medium-sized, Clerkenwell-based media business explained, "it's about mostly employment and the perception of clients, those are the big drivers, because let's face it, we're paying lots of money for a small office, that's not that convenient."

These observations reflect those of Pratt and Hutton (2013) who noted that the games companies are attracted to global cities and seem to tolerate high rental values to preserve the good branding of location. How did these digital companies manage the costly situation that they found themselves in? The London case study evidence shows that start-up companies in both niche product areas were more likely to work from home for longer, even once they started to expand. Many London mobile games companies seemed to have been developed around kitchen tables or even in the garden shed; thereafter, they looked to move into the revered Clerkenwell area, and managed the rental values by sharing with other games companies. The process of

"moving on" from being home-based to Clerkenwell was vividly described by a games company marketing director:

> *It was affordable because it was a shared office. So, the guy who was renting the studio has been there for ever. And he was friends with the landlord, and the landlord was friendly. He was great, so it was a good deal and cheap for us. He covered all the bills… It was like £15 per square foot. It was an old crappy loft space. white walls, very rickety wooden floor, and not a lot else. The odd leak. We kind of just moved in. We've never done an office. We've never sort of, you know,* [said] *"let's cast our branding" and do that, we just literally stuck some desks in and got going.*

The London cybersecurity start-up companies exhibited similar growth patterns, albeit that unlike the games companies, they may be based overseas, and manage high London rentals through taking flexible working spaces or even simply purchasing a London address.

Unlike in the findings of Champion (2014), there was little evidence of firms moving away from their workplaces in Guildford and Malvern (albeit that the in-cluster bias of the survey group may have hidden the evidence), probably because it would entail giving up the all-important place brand identity. Consequently, they "managed" the workspace availability situation, sharing offices and cramming in staff when necessary. Three interviewed maturing games firms and one cybersecurity firm, all in London, were found to have relocated to neighbouring cheaper districts, driven by their more extensive space requirements and a strong urge to individualise their own properties. Whilst all the relocating firms expressed regrets about leaving their beloved Clerkenwell and Shoreditch respectively, they remained well connected through the good public transport system and the retention of the capital's global cachet for attracting talent. In all cases, they perceived that the staff felt more comfortable and attracted to their old districts, as well as missing the cultural vibe associated with the places. Pratt (2011) writes about the "feel good" factor associated with the media cluster in general, in areas contiguous with Soho such as Clerkenwell. This is an understandable trend, suggesting that metropolitan-based clusters are more fluid than provincial area–based clusters, which could render them less effective, or even signal their demise: a point developed in Chapter 6 and discussed in work by Nathan and Vandore (2014) in respect of Tech City, and Osman (2015) in respect of Silicon Valley. However, neither of these studies has probed the phenomenon deeply.

The relatively few studies of firm adaptive behaviours to their environments are found in entrepreneurial literature (Stam and Spigel, 2016; Mack and Meyer, 2016; Houston and Reuschke, 2017; Audretsch et al., 2018). There is recognition that the behaviours are important in terms of understanding the process of urban agglomeration. The insights afforded by this study take this

understanding further by highlighting the importance of these behaviours, and their differences by niche sector working practice, as well as showing that the agglomerative processes are more nuanced than has hitherto been recognised. Furthermore, there are reactive and adaptive effects of the property market itself which should not be overlooked. These dynamic elements are the subject of the final investigation in Chapter 6. What is clear is that the local clustering economy is volatile, complex and never certain.

4.4 Conclusions and contributions to the literature

This chapter has presented an exploration of the factors causing the co-location of the digital businesses in the four case studies. There were both similarities and differences in business practices and characteristics between the two niche sectors which fed into the complex phenomenon of co-location, but common to all was the importance of preferred workspace supply, transport connectivity, and workplace reputation and imagery. It was striking that whilst traditional factors such as transportation were described as all-important, identity with place and workspace outweighed these factors for at least three clusters (Guildford, Malvern and Shoreditch), adding to the developing literature on the importance of cluster reputational benefits and spatial imageries to niche sector digital firms (for example Van Heur, 2010b; Nathan et al., 2018). Only the cybersecurity firms of Shoreditch seemed driven by the usefulness of being near their clients, and they took advantage of flexible working spaces which fit well with their remote and flexible working practices. However, even they enjoyed the association gained by locating near the technology firms of Silicon Roundabout. The emblematic value of workplaces seems to be a powerful locational driver in the increasingly virtual business environment.

The relatively novel approach of this study has flushed out a rich set of data which will add positively to the identified research evidence-base gaps and literary debates surrounding the primary sources behind co-location (sections 2.2.2 and 4.1), We start to recognise the nuance and granularity of cluster characteristics and dynamics as called for in the cluster evolutionary literature (Ketels, 2009; Osman, 2015), with fresh evidence adding to a number of literatures, including the timely supply of work space (Jacobs, 1969; Segal Quince Wicksteed, 1985; Cameron and Coaffee, 2005; Barnes and Hutton, 2009; Champing, 2010, 2011), and the role of workplace imageries (Nathan et al., 2018; Van Heur, 2010b). There are several specific additions, including highlighting the similarities and contrasts between the locational motivations of creative and also technologically niche sectors, thereby assisting in redressing the current bias of studies towards the creative sector (Van Heur 2010a). Furthermore, the investigation provides contrasting evidence on the working lifestyles of millennials, (McDonald, 2015; Moos, 2013, 2016; Lee, 2017; Florida, 2018) and raises the possibility of a gender bias to workplace preferences (Massey 1994,

1995). Now that London niche-sector millennials have grown older, they seem to have adopted a commuting lifestyle, making effective transportation infrastructure more important. Also, the study brings to the fore the serendipitous result of planning policies protecting the supply of preferred and emblematic workspaces, in the Guildford and Clerkenwell cases, reflecting and supporting similar work by He and Gebhardt (2013). Finally, the complicated roles of workplace reputation, niche sector passion for work and credibility are a fascinating output, adding to a very small and limited literature (Bank, 2012; Deo, 2012), which would be a useful area for further study. The subject of co-location continues to intrigue. These observations and areas of new evidence will be developed and commented on further in the following chapters.

Chapter 5 Local face-to-face interactivity and knowledge flows in digital clusters and the significance of the built environment

5.1 Introduction

This chapter presents the second thematic analysis, relating to the significance of the built environment to the second characteristic of clusters identified in Section 2.2.3, that of local face-to-face interactivity and associated knowledge flows (Marshall, 1890; Porter, 1985).

This analysis is an opportunity to probe the more nuanced quality and nature of local knowledge exchange relating to smaller niche clusters and interrogate why some niche sector clusters are highly interactive and others less so. The analysis specifically seeks to understand In what way the working practices of the digital businesses influence their needs for face-to-face knowledge, how do the respective built environments fit the local face-to-face interactivity needs of the firms and how are the businesses adapting where gaps are evident?

Section 5.2 explores the local face-to-face meeting requirements of the interviewed firms in each case study, why they need to meet up, and how this is facilitated through their respective built environments. Section 5.3 explores the deficiencies in terms of interactivity, how the built environment is implicated, and to what extent firms have adapted to overcome interactivity deficiencies. Section 5.4 consolidates the findings and seeks to answer the research questions.

For this investigation, “business models” are defined in terms of their value chain components, who the customer is, and what the required inputs are to produce a valued product at an appropriate price (Druker, 1994; Magretta, 2002). Business “working practices” refer to the more nuanced operational procedures, which are affected by and tied into the business model and working cultures.

Furthermore the exploration is able to investigate cluster associated “buzz”, and the role of the flexible working spaces which are associated especially with the London cybersecurity firms (Section 4.2.3). Research suggests that they facilitate interactivity and knowledge sharing (Capdevila, 2014; Madaleno et al., 2018) and they are seen as useful cluster development interventions. Yet their effectiveness is unclear. How do built form and design affect this role? Is there a difference between public versus privately provided workspace and mixed versus specialised sector market focus, (Madaleno et al., 2018)?

5.2 Case study explorations of local face-to-face interactivity, knowledge flows and the significance of the built environment

This section explores the local face-to-face meet-up needs of the clustering businesses in each of the case studies, seeking to understand why they meet up, the nature of the associated knowledge flows, and how this is facilitated through the built environment.

5.2.1 The Guildford games cluster

Face-to-face interactivity in central Guildford seems to be ubiquitous, relating strongly to their dependence on skilled human resources. Guildford is a centre of indie developers and the home of the Unreal and Unity game engines. Developers speak the same technical language. As the CEO of one small company said:

> *There are two main leaders of games technology, Epic Games use Unreal Engine and the other is Unity. Almost every game is built on one or the other, and the expertise is in Guildford because that is where they started. You'll find people in Guildford changing the source code of Unreal Engine which is used all over the world.*

As "indie" developers, they take sole responsibility for the development, publishing and sales of a new game, usually for consoles but increasingly for mobile phone use, which entails enormous upfront investment and risks. As described in Chapter 4, there is a churn of skilled workers who stay in the town and know each other well. Furthermore there is a collective working culture, supported not only by commonalities in technical language usage, business goals and models, but also by the fact that the professionals are 99% male, with a similar "jeans and jumper" relaxed attitude to coming to work. One founder described how

> *they may roll into work at 11.00 am and roll out at 7.00pm in the evening or stay up all night. They might work in their pyjamas. They're not exactly starving artists, you know.*

It appears that these characteristics have led to the building of a strong community, clearly preferring each other's company, rather than reaching out to other sectors. The local Chamber of Commerce described them as being "secretive", albeit that the long hours and pressured work culture means they are inevitably inward looking, especially as a game draws near to publication. There is a hardworking, strongly bound community of professionals in the town, and an efficient labour pool mechanism with professionals moving from older businesses and setting up new

ones. The process inevitably produces strong knowledge spillovers, much in the way described by Saxenian (1995) in her classic description of Silicon Valley.

The industry relies on a project approach to games development, often under immense pressure, which necessitates quick access to freelancer talent. Central to this labour pool mechanism is information and gossip about the available talent, job possibilities and the health of projects, and a key reason for co-location is to ensure that firms are in the "thick" of the employment-centric information. In the words of two interviewees, "the cluster is about talent," and, "we have got talent right on our doorstep. Whilst we are building the key functionality and the core technology, yes, being in Guildford is absolutely key." The companies are in strong competition for this talent, which is in such short supply that they are not beyond poaching from other local companies, as evidenced by this response from the founder of a medium sized company: "With all the games companies here, you know, essentially we can get people who work for those companies to come here."

Central to this information exchange is the fact that it is a tight-knit community: most games professionals in the town know each other, often having worked together before being disbanded when a project finished. This niche-sector "project ecology" model compares to that described by Vallance (2013) of the Newcastle-upon Tyne games cluster, a network of relatively small groups with a community and associated "buzz" through social interactivity and knowledge exchange, working on a project basis. Information flows are often affected by face-to-face interactivity, but also supported through social media and a virtual "buzz" (Bathelt and Turi, 2011). Interestingly this labour pool model compares with the classic descriptions of the dynamics of industrial districts (Marshall, 1890; Sargent-Florence, 1948). What was not considered in those times was how the built environment affected interactivity.

Easy walking distance between companies in the town centre enables serendipitous meet-ups in the street, a feature also recognised in the work by both Jacobs (1969) and Pratt (2009), and Florida's "walkability" distances (2018). The Guildford games industry dominates the office economy of the town centre (described in Chapters 4 and 6), and therefore the meetings are generally with same-sector peers, rather than Jacobs's heterogeneous linkages. One freelancer explained how she was always bumping into games people, "even just popping down to the shops in my pyjamas to get some milk". Some of the professionals enjoyed living in close proximity to their studios, much in the "loft living" style recounted in the New York study of Neff et al. (2005). This intertwining of the working lifestyle of creative professionals was described by Florida (2002). Guildford games professionals enjoy gatherings in particular local pubs in the evenings after work. The town centre is well endowed with bars and restaurants: a quick Google search shows that

there are some 180 outlets, with some pubs particularly associated with the games professionals. As described by a London CEO, comparing London to Guildford,

> *There's this one pub in Guildford, and someone asked me at a conference to like, how to get into games. What I would do is go to this pub on a Friday night, and just buy people drinks and speak to them and you'll get into the community, because it's so small.*

There is clearly a relationship between the number of pubs, the size and nature of a business community, and the density of built form that best supports interactivity, and which is possibly worthy of further investigation.

Adding to this geography of interactivity are networking events and "Games Jams", where developers are invited to stay overnight in a pub. These appear to be regular occurrences, often supported by the local authority, Surrey University, the Local Economic Partnership (LEP) or by UKIE. There is also an annual Games Festival in the concert hall in the town centre organised by the Borough Council, and regular exhibitions and conferences, facilitated according to Venuefinder.com by some fifteen exhibition and conference venues.

The geographical proximity of the railway station is also important in terms of facilitating face-to-face meetings in London and commuting patterns of the workers. The fast train service to London helps to reinforce a feeling of job security, as explained by a Guildford CEO, "because it's very likely that you'll find something within kind of walking distance even," but "at worst, you might have to commute to London". Again, the connectivity seems to be about employment opportunities, Guildford being within 40 minutes by train of London, and therefore considered part of the "labour pool" effect discussed in Chapter 4.

The sharing of premises by young games companies, especially in Walnut Tree Close and the start-up space Rocket Desk, also increases interactivity. The effect is to generate typical entrepreneurial business support in the manner described in the recent literature, for example Stam and Spigel (2016), Madeleno et al. (2018) on incubators and accelerators, and Capdevila (2014) on co-working spaces – that is, as a "kind of emotional support" (young entrepreneur), Similarly, proximity to town centre business support services is useful, and these have responded by being able to offer specialist services to support the games industry. As pointed out by a founder, they offer support "like accountants… yeah, that's kind of useful." Not only is business support information facilitated through the local built environment and co-location, but also technical information exchanges were evident between games professionals. For example, one employee worker working from home explained how he was easily able to "focus test" his game, by sharing

it with a local group of game professionals. The collaborative possibilities were also noted by another, who said, “We’ve formed interesting friendships and partnerships with other companies in the area. Yeah, we’re really lucky in that.” These relationships seem to facilitate the type of innovative partnerships envisaged by Porter (1990) and his disciples (for example McCann, 2001; Ketels, 2009), who have written extensively about the role of clusters in terms of heightened regional competitiveness and innovation. Furthermore, there is also some evidence of inter-cluster interactivity and innovation, much along the lines of the heterogenous cross linkages described by Jacob (1969). Two VR-based games companies were working respectively with the contemporary music sector and the car racing industry, both of which had a base in and around Guildford. The collaborative possibilities were just starting, as one of the founders explained:

> *And we are using games engine technology to help car designers design cars. Guildford is now at the forefront of the entertainment industry and enterprise software, you know, everything can be built in games and be successful with them.*

This mesh of proximate built form, and meet-up places and events, connected by working and social relationships and driven by an urgency of exchanging talent-related information, which is best communicated through face-to-face interactivity, makes for an efficient information-sharing mechanism which games firms feel they cannot afford not to participate in. As one medium-sized company CEO said, “There are no secrets in Guildford.” What is more, two respondents described how, once established, the effect continues with spiralling growth, stemming from the frequency of meet-ups and the cluster’s strong connectivity which creates further interactive opportunities. A games freelancer said about the Games Jam that, “It couldn't really work as well if it was somewhere else”, whilst the CEO of a small firm explained how there is a “network effect where one thing leads to another”. There is evidence that this dynamic milieu has created something which is above and beyond a simple agglomeration of firms, with Guildford firms continuing to achieve global success. One CEO described this effect vividly:

> *Guildford punches way above its weight, you know. I’m always amazed by the level of success that small games companies and small creative tech companies can get in this town, you know. So there’s a studio called Hello Games. What a tremendous story of success. A small tiny team of like fifteen guys, and they make this game called “No Man’s Sky”, which grew to 85 million. Their CEO Sean is now on primetime TV talk shows. Yeah, it’s bizarre… the sum of the individuals is greater in the mass, the cluster does create something else.*

Perhaps the Guildford games cluster is a good example of “something being in the air” (Marshall, 1890), something ephemeral which is clearly encouraging creative competitiveness and

innovation much in the way described by Michael Porter and his followers. Having explored how firm working practices define the strong need for trustworthy employment information, this study has described an exemplar “labour pool” cluster and shown how the dense built form of Guildford town centre has supported these competitive needs.

5.2.2 The London games cluster

As described in Chapter 4, this relatively new cluster is based on mobile games technologies. The firms are centred on Clerkenwell, often occupying workspace in the converted old printing works which are a feature of the area. They associate with the media and advertising clusters which have been centred on neighbouring Soho for many years (Clare, 2010). Like the Guildford firms, London games firms work on a project basis and are very dependent on scarce talent, albeit that they rely on a narrower talent base, projects are less risky, and firm growth is more incremental. Furthermore, mobile games production relies on a narrower talent base, the games being simpler and less extravagant to make. Employment requirements reflect this business model, in that whilst they are reliant on scarce professionals, they are relatively less urgent and less diverse. Accordingly it appears that there is less motivation for face-to-face interactivity. The employment search process is generally effectively managed using social media. As described by one freelance project manager:

> *We do it on a project-by-project basis, usually for the duration of the project. We are very well connected with our peers and that sort of thing, so we find it relatively easy to find the right people for the jobs. We do it all ourselves, Twitter, social networks. It works.*

The firms demonstrated a reliance on virtual interaction, much in the way described by Bathelt and Turi (2011). However, some face-to-face interactivity does take place, although the survey showed that its role and the nature of the knowledge flows differed by business life-cycle stage and business model. As in Guildford, entrepreneurs enjoyed business support from more mature firms, often facilitated through the sharing of offices, and interacted through attendance of specialist events. London is one of several hubs for international events, as shown in Figure 5.1:

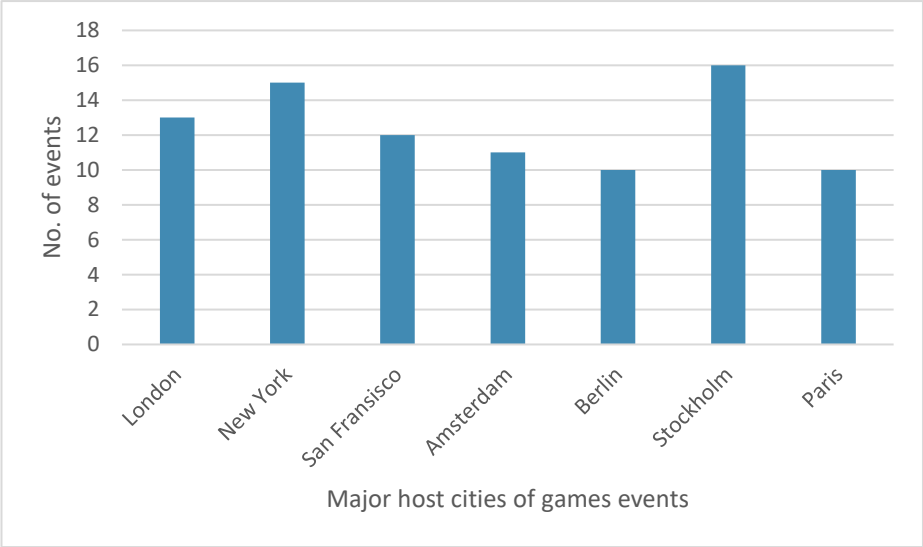


Figure 5.1 Games events by global centre, July 2019–January 2020

Source: Eventbrite

Events also seemed particularly useful for the entrepreneurs both in terms of marketing their products and updating themselves. A games freelancer said, "Yes I go to exhibitions, to see what's the latest. London is good at that." UKIE, the acknowledged hub for games professionals, proximity to which was mentioned by several Clerkenwell-based interviews, was also a useful centre for networking and events and was seen to add to the attraction of the area by providing business support and connections. The remote-working games company CEO was particularly enthusiastic, explaining how, as members, they could hold their staff meetings there:

> *We meet at UKIE… and that's in Holborn. So, once a fortnight we get together. It's somewhere where there's lots of industry people buzzing around. Anyway, we get to sort of be in the spotlight there and… we can do business planning or important meetings with key stakeholders. We put up certain banners and if investors are coming along, we bring along our BAFAs* [British Arts Festivals Associations] *and awards… we're tapping into a hub and what we found is, you know, it means that we can be seen by a far wider group,* [because] *people are coming in from all over the world, investors, publishers, people. So, you know, they will see that we're there. And obviously, you know, we're in UKIE's mind and having I guess, more secure conversations with key people there, when we're in. It's incredibly symbiotic!*

The events and the availability of appropriate conference centres were important in supporting face-to-face interactivity in this cluster. Social proximity and evidence of a niche sector epistemic community (Boschma and Franklin, 2010) are demonstrated, and reflect the findings on temporary clustering, (for example Currid and Williams, 2010).

A further feature of the mobile games business model is reliance on marketing. Mobile games are produced relatively easily, which explains why some 500 games are released globally every day (Gamasutra, 2016). To be successful and to make money, young mobile games companies must attract significant finance to launch and market the game effectively. A young games company founder explained:

> *Mobile games changed things, there was now serious replicable money to be made… London being a capital for tech investment… which mean*[s] *that the vast majority of mobile companies in London have taken investment… I bet you money, if you map those games clusters against tech investment location, they would correlate, you know.*

Florida and King (2018) recognised this relationship in respect of start-up ecosystems, and certainly London attracts more venture capital investment than any other European centre (press release by the London Investment Agency, 10th June 2019, based on Pitchbook data, June 2019). London scores highly in a ranking of global foreign direct investment (by number of projects) for technology companies over the last ten years, as shown in Table 5.1 below.

City	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	Total
London	43	62	93	111	95	90	115	96	120	91	916
Singapore	54	79	76	75	92	100	74	61	79	79	769
Sydney	22	34	44	67	49	50	45	39	35	26	411
Paris	15	22	36	30	40	47	42	41	91	46	410

Table 5.1 Tech investment programme by city showing numbers of projects

Source: Pitchbook data, June 2019

The main tech-related venture capitalists (VCs)are listed in Table 5.2 below, of which three of the eight are to be found in the EC1 and EC2 postcodes, which coincide with the Clerkenwell and Shoreditch districts – suggesting that face-to-face interactivity is important.

Venture capitalist company	Postcode location
Notion Capital	W1
Passion Capital	EC1
Octopus Ventures	EC1
Balderton Capital	WC1
Connect Ventures	EC2
Index Ventures	W1
Episode 1 (UK gov)	WC1
Fuel Ventures	N1

Table 5.2 Top VCs by London postcode

Source: https://www.rocketspace.com/tech-startups/8-london-vc-firms-tech-startups-need-to-know

The more established games companies are likely to have forged a relationship or a partnership with media and advertising industries, which, as discussed in Chapter 4 are centred in neighbouring Soho (Clare, 2010). Again, proximity seems to be important: many of the larger global publishers, including Google and LinkedIn, are located in Clerkenwell. London, boasts the largest global concentration of games publishing offices. However, whilst Clare (2013) suggest that proximity to clients and face-to-face interactivity are key for the advertising industry, the evidence of a reciprocal relationship in this survey was more mixed. One CEO of a small games company said,

> *It's really nice to go and see clients. They're not far away. They can come and see us, which is nice, and they like the area. So that's good just starting a project with an agency. And you know, if there's a problem, I'll just go, "I'll come round". It's… brilliant, you can just sort stuff out.*

London's efficient transportation networks were also highlighted as supporting the relationship with publishers. Easy access to airports provides useful geographic proximity. A founder of a small business explained:

> *Okay, well, if we have any questions or if* [we] *have a falling out, we can fly to Stockholm in two hours and go see them directly face-to-face. Like that's like a big benefit.*

Yet other interviewees did not rate face-to-face meet ups at all, suggesting that the customer relationship had changed, and was reliant on virtual communications. A media/games agency director explained:

> *No, it's all changed. We don't meet clients. You know, we don't even speak to them. We do sometimes have Skype calls and things, but the actual amount of contact with clients has changed massively… Now clients never have the time to come and sit with you. They used to… come out for lunch, you know, sit with the agency, And it was it was a kind of, you know, a premium kind of, quite a nice experience to have. But that doesn't happen now.*

These insights appear to add nuance and insights to the literature on virtual "buzz" (Bathelt and Turi, 2011; Grabher and Ibert, 2013). Clare's study is some eight years old, so it may be that this study is picking up on changing trends and a developing reliance on social media, or that games professionals are more comfortable with social media than advertising firms. A plausible explanation that could be drawn from this study is that Clerkenwell attracts both publishers and games companies alike through their workplace preferences and historically based associations with the area (see Chapter 4). Information and knowledge flows are facilitated due to the resultant geographic proximity, rather than co-location being the motivation for the cluster. Similar mixed (and perhaps emerging) trends are observed in recent work by Brydges and Hracs (2019b) on the fashion industry of Canada. This study adds further insights and raises questions which might benefit from further study.

For some London games companies, face-to-face interactivity maybe less about formal knowledge exchange and more about informal exchanges, often between creative sectors. In his study on games companies in Ireland, Kerr (2012: 124), observed that the interactivity of the local social milieu and "buzz" related to subtle and informal knowledge flows. One CEO in this study explained:

> *It's about "rubbing shoulders" with other industries located in London, in particular the creative industries.*

Another CEO stressed the subtlety of what may be going on:

> *It's not even, like just getting into a room and talking, it's the fact that we would walk out of the Tea Building in the middle of Shoreditch, into the Box Bar across the road and there'd be some DJs on there and there would be some people listening to cool sounding music. And then you'd make friends and you'd chat to different people. And sometimes it's passive, you know, as opposed to active so… It's the vibe.*

Face-to-face interactivity in London may be less about business needs and more about lifestyle and the enjoyment of a vibe, as promoted in several studies (for example Florida, 2002; Currid and Williams, 2010; Nathan et al., 2018).

Figure 5.2 Clerkenwell restaurant

Source: https://rwapplewannabe.wordpress.com/2008/08/31/the-modern-pantry-clerkenwell/

Local "buzz" is important but appears to be about subtle forms of information flow and interactivity, in a fun and interesting context. Bars, restaurants and local markets were named as the favourite "extended workplace" meet-up venues for the games companies (Martins, 2014). In addition to restaurants and bars, interviewees often cited markets as being important foci of interactivity especially at lunchtime. The markets are vibrant and popular places for lunchtime, which have perhaps been overlooked in studies on cluster social milieux and would be worthy of a more thorough examination. A quick Google search shows that Clerkenwell in an area of approximately one square kilometre boasts some 286 bars and restaurants, which equates to 6.3 establishments per games business. It is also home to three daily accessible markets: Leather Lane, Smithfield and Exmouth.

Whilst social, informal interactivity is commonplace, it is noteworthy that unlike in Guildford, no pubs specifically associated with games have emerged in Clerkenwell, supporting the idea that face-to-face interactivity is not about niche-sector business knowledge needs. A CEO of a small company said, "There are no pubs [for games] except maybe for indie games… London being such a big place that obviously that doesn't really happen." However, this study can raise the question of whether the phenomenon is culturally related. Do mobile games companies have a different

culture to their indie cousins, or does the relative spread of companies play a part in this observed lack of niche-sector interactivity? A freelancer suggested that perhaps mobile games companies are hungrier to succeed and grow: “I think there's a lot of meet-ups in London around that [indie scene]. The community there is quite separate from like, the more sort of, you know, ‘we want to grow a company and employ people’.” Equally the built form of Clerkenwell, combined with a more heterogenous and larger working population, means that serendipitous meetings are rare, despite a higher concentration of games businesses in central Clerkenwell than central Guildford (forty-five firms compared to twenty (Mateos-Garcia et al., 2014)). There is a discussion in the literature, led by Jacobs (1992:178), as to the importance of the size of a block in terms of facilitating these types of meetings. Guildford’s centralised, condensed form probably compares to Jacobs’s “small blocks”, some 20 firms are within 50–200 metres of each other, as shown in Figure 4.1. Clerkenwell games firms by contrast are more spread (Figure 4.6), within a mixed and dense environment. Indeed the London firms were aware of the relatively low density of games businesses and professionals, reflecting the fact that that a high proportion of professional and businesses work from home, and there is a more mixed economy than in Guildford. The marketing director of one established company said:

> *In terms of like a hub of games in London, if you like it is just spread out more, you know, it's not as concentrated* [as for example Guildford]*… There is a churn of people who can equally well work from home.*

A young CEO said,

> *London is strange for a games industry, I think it's very, like, broken up and, kind of, in different places. Whereas when I go to, say, LA, or San Francisco, you know, you’ll walk down a road and you’ll kind of be that there’s this game developer next door. And there is like another one next door to that. It’s that really, like, hot, you know? Whereas in London, I mean, I don't know of anywhere in particular, where there were, like, a group of studios in one place.*

The London games community seems to lack physical locational specificity, in contrast to Guildford. This is due to a mix of working practices factors, and the economic and built environment that they find themselves in. The relatively good public transport connectivity also has a bearing. Notably, all interviewees were positive about its availability to support both commuting patterns and the ability to work from home, which ultimately helped to save costs but had a diluting effect on the cluster. One founder of an established games company had the perception, despite the clear concentration of firms, that

> *London doesn't really have that* [a cluster]*… you can work in Highgate or you can work in Shoreditch, or you can work in Victoria or wherever. You don't need to be rooted in that one place, or one particular area.*

Commuting patterns impinge on evening social meet-ups. There was no evidence of the "loft living" lifestyle of games companies as in Guildford and in New York (Neff et al., 2005). As one marketing director said, "Although we're based in London, not many of us actually live in London." Their staff demographic is such that

> *about half are older, with families, and thus have less inclination to do stuff in London, and half are much more junior, who may be more willing, but don't have the money to keep pace in expensive London.*

Another CEO of a similar company said much the same thing:

> *Because I'm married and* [have] *got kids now, so I don't do the socialising bit. And our lot, you say let's go out on a Friday night, and then we get some beers in and we'll play board games and stuff like that. They are sociable but they've all got partners and things out of London. So, they are like, "I'll stay here", or "you know, I don't want to do a late night in London, it's going to cost me to get there and get home."*

So is the demographic of London games professionals changing? Are we seeing more evidence of these millennials growing up, an avenue of research proposed by Brydges and Hracs (2019a)? Or is this further evidence, noted in the Guildford study, of the more mature firms preferring to remain isolated, as described in classical business management literature (for example Kelly and Helper, 1997)? Two of the London games companies mentioned this trait, in relation to the threat of staff poaching. A CEO of a remote working business said, "We didn't feel we needed to be next door to anybody," and a games/media production company based in EC1, recognising the hub of games in the area, said that if they were a pure gaming company, "I would probably want to locate somewhere which is a little bit more like an island."

Overall face-to-face interactivity between these mobile games companies was not a high priority, unlike in the Guildford cluster, and they were more reflective of Pratt's (2009) observations with respect to the general insularity of the games businesses in San Francisco. However, Pratt fails to explain the reasons behind this. This exploration suggests that these weak linkages may exist for a combination of geographical reasons including a perception of low business and worker density due to the spread of workplaces; remote working practices; commuting patterns; and a fear of losing staff, as described in Chapter 4. However, there may also be another reason which is worthy of consideration, relating to the immaturity of the industry/cluster. The mobile games

industry is younger than the indie industry (see Section 3.3.2), so a related cluster had had less time to establish itself than was the case for the indie games cluster in Guildford. This means that not only have spatial factors been against face-to-face interactivity in Clerkenwell, but there may be an added temporal element in that there has not been time for companies to grow, create spin-out companies, and start a churning, interconnected labour pool. One CEO pointed out:

> *It's very strange. Because it's not like the companies that went out of business or moved, had people stay in the normal, kind of like, the Dundee*[24] *way of, you know – founding company grew massive, then splits and you know, everyone's got mortgages and kids, and then they're like, well, "I'm starting my own company", and it just becomes a cluster.*

There may be an evolutionary aspect to labour pools and digital clusters that could be explored further. Certainly there was evidence of sectoral development, in the form of the development of a more open business culture, and the beginnings of an institutional framework (Maskell and Malmberg, 2007). Furthermore, some of the first wave of mobile games companies are becoming successful, such that they could become anchors for the industry. Already some are taking on the role of promoting networking functions. A CEO of another older company pointed out the change as he saw it:

> *London is a bit funny like that, it can be quite isolating, in a way. But I think things like this are kind of breaking that down… Companies like Space Ape or Natural Motion are much more "out there" than we are. I don't know whether people in that sort company are much more sociable and just start thinking like events and stuff.*

A young start-up studio CEO was critical of those that simply relied on technology for their interaction, suggesting that they were a certain "type" of professional. He was very supportive of more face-to-face interactivity, saying,

> *Maybe it's the trust thing, that you can't communicate with a Twitter feed, or something. To give an example, we wanted to launch this game on Switch; if you're not in the same location, you have to set up a phone call to sit down, and always for half an hour you mess around trying to sort it all out. It takes two weeks to get that interaction going. The more physical connections you have the more exponentially these connections will benefit us… the benefits of meeting people face-to-face are*

[24] Dundee is a recognised games cluster in the UK Games Map (Mateos-Garcia and Bakhshi, 2014).

> *huge. I don't see that ever changing to be honest, even in a really uber high tech business like now, with clients all over.*

His enthusiasm was infectious. His company shared their workspace with three other firms and were seeking to increase the number, as well as offering networking events. They were reaping the benefits in terms of collaborative introductions:

> *Epic Games, who own Fortnite and are one of the main forces in the industry, came into see this film we organised, and they were introduced to us and we were able to start a discussion with them just off the back of that, and now if that on its own does well it will justify the whole lot.*

He summarised the benefits of the whole collaborative venture, saying

> *It's not about the money. It's about people being able to learn from each other. I mean, it really is about making business. I mean, so I love the fact that everyone sees each other, but actually, for me, it's still a business thing. The business benefits of learning stuff and getting introductions are really high.*

A factor that may be contributing to a more interactive and open culture in the London games cluster, is the requirements of some of the new funding opportunities. A CEO explained how they raised funds through Kickstarter, an open access fund which notably is more easily available in and around Tech City. Part of the arrangement is that a borrowing business must stay in touch with their loan community, which he saw as a benefit for the erstwhile somewhat shy games companies. He pointed out that this means

> *you can't just kind of go and disappear and hide and do all your stuff in secret, you need to engage with the community constantly.*

Clearly something is happening. Whether it is cluster evolution or whether there is a sea change in the next generation of entrepreneurs is unclear, but certainly there is a difference in cluster interactivity between the clusters centred on Guildford and Clerkenwell. The latter is less motivated to undertake face-to-face interactivity, and is not assisted by the built form – albeit that there is discernible change in the air, with trust shown to be of importance in the digital economy. These insights will add to this niche field of the literature. As pointed out by Hracs (2010), in respect of the digital music industry, we are clearly in an age of choice when it comes to meet ups, with meeting up in person for matters requiring a deeper trusting relationship, and virtual communication being used for either established relationships or lower-priority matters. Localised "buzzing" communities are evident, but at the time of the survey and for this niche

sector, that was less for formal communications and more for informal and lifestyle contact. Again, nuance is added to the more generic digital clusters studies, which assume that formal knowledge flows are effected by localised “buzz” (for example Storper, 2013; Martins, 2014).

This exploration provides an interesting contrast to that of the Guildford study. Face-to-face interactivity is relatively weak, and less valued. Contributory factors noted include the differing working practices of the mobile games industry, the age of the industry and a reliance on social media. However, once again the built environment is shown to be a valid factor for inclusion in the brew of causal factors – with the relative spread of the cluster, in terms of workspace availability and dispersive transportation effects, making meet ups generally more difficult.

5.2.3 The London cybersecurity cluster

As described in Chapter 4, cybersecurity businesses have tended to base themselves in London to connect with clients, especially the financial market of the City of London. The London offices are often the marketing and sales offices of cyber companies based in the provinces or overseas and typically, as described in Chapter 4, they have a remote style of working, supported by workspace in one of the many flexible working spaces that have mushroomed in the Shoreditch area. This client-centric business model relies on face-to-face interactivity and associated knowledge flows, much in the way described by Isaksen (2004) of the software cluster in Oslo and other studies on value chain clusters (for example Ghemawat and Nueno, 2003; Storper and Venables, 2004). Formal face-to-face meetings tend to take place in the offices of the clients, whilst local bars and restaurants provide client entertaining venues and are effectively an extension to the vendors’ workplaces. The technologically based surroundings of Shoreditch and Silicon Roundabout make for comfortable settings for these technology-orientated parties, the cybersecurity professional and the client IT professionals to meet. The benefits of this type of face-to-face activity and the development of a community in the Shoreditch area were described by the marketing director of a large cybersecurity company: “Lots of tech companies and nice places and bars… it’s good for when the consultants go out on meetings with clients, there’s a commonality of where to go and have a drink or a meet.”

A Google search identifies 270 bars and restaurants in central Shoreditch, which is approximately 5.9 per business, slightly lower than for Clerkenwell . This “buzzing” milieu of technologists based in the Shoreditch area has long been recognised in the literature (Foord, 2013; Nathan and

Vandore, 2014), with the area being dubbed "Tech City" and "Silicon Roundabout".[25] As for the Guildford cluster, there are clear primary knowledge needs for the cybersecurity niche sector. This evidence contrasts with the more informal knowledge flows of the games firms of Clerkenwell and shows that "buzz" can be differentiated according to niche sector presence, adding granularity to the existing studies cited above.

In terms of intra-cluster face-to-face interactivity, like the games firms of London, cyber professionals were "not sure that there is any particularly community or vibe". Yet again, this is evidence of the effect of a relatively low density of workplaces, as shown in Figure 4.17. The effect is compounded by the diverse business populations of the working spaces in which the cybersecurity firms find themselves. According to recent literature, they should provide interactive and "micro-clustering" opportunities (Capdevila, 2014; Madeleno et al., 2018). However the evidence for this within London's cybersecurity community was thin. There seem to be several reasons for this. These companies are more often cybersecurity vendors and servicing agents, and have little in common with the general population of flexible working spaces. One CEO complained about having to share "with the likes of accountants and people". The cybersecurity companies that occupy these spaces do so for convenience, as well as being intermittent occupiers of the workspaces. Furthermore, they are rarely at the entrepreneurial stage of business development, a stage at which flexible working spaces seem to bring the most benefits to companies (Stam and Spigel, 2016; Madeleno et al., 2018). These workplaces do however provide formal and attractive meeting spaces for client interaction, should the companies require it. The evidence suggests that a bespoke cybersecurity shared work place might be more conducive to face-to-face interactivity and useful knowledge flows, and it is interesting that this is exactly what has happened – in that a bespoke cybersecurity co-working space has recently opened in Canary Wharf.[26]

Typically for a value-chain cluster, the other key relationship for cybersecurity firms is with the development part of the organisation. Face-to-face meetings are the norm, and as this part of the organisation tends to be outside London or overseas, transportation is key to the relationship. As described for the London games firms, the cybersecurity companies enjoy the easy access to International airports, and also its rail connectivity. Good rail linkages appear to be the cause of a mini-hub of cybersecurity vendors locating in and around Paddington, the mainline railway station serving the west of the country, a hotspot for cybersecurity development which will be discussed

[25] Prime Minister David Cameron was responsible for developing the branding of the area based around Old Street as "Silicon Roundabout", as part of the Tech City Initiative in 2012.
[26] Based in Queen Elizabeth Olympic Park, the flexible working space is called Plexal. https://www.plexal.com/

in the next section. This cluster model, unlike that of the games industry, is more aligned with Bathelt's ideas of both local and global knowledge flows sustaining a thriving mechanism of knowledge flows (Bathelt et al., 2004). London serves as the hub for these organisations, which often rely on remote teams and need to travel in for team meet-ups and client meetings. One founder explained of his teams that, " if they're going to meet up, they're going to meet in London, it's just [a] very easy, accessible place".

There was little evidence of these cybersecurity companies enjoying the more informal forms of interactivity described by the London games firms. The interviewees revealed mixed responses to the idea. One potential difficulty for industry interaction in London is that many workers are based outside of London, making meet-ups difficult but supporting the use of social media. As one entrepreneur explained, much in the manner as described by Grabher and Ibert (2014), and the work on virtual "buzz" and epistemic communities, "[we] meet all the time, using Skype and social media and things like that, to do our communication." Indeed, two other lone entrepreneurs did not particularly see the need for niche sector interaction at all. One talked of the issues of "protecting [his] platform and not wanting to be copied"; while the other, based in Bulgaria, admitted to possibly missing out, but did not see it as being a particular problem. However, again like in the London games study, there was mixed evidence: perhaps because of their more creative focus, some developers were very enthusiastic about face-to-face networking. One founder of a cyber-development company based in Waterloo held joint breakfast round tables of 50–100 people, to attract like-minded founders, in their offices. He said,

> *We work very closely with our peers, you know, we share marketing activities, we spend a lot of time with other founders comparing notes and things. So being close to other companies is quite helpful.*

His view was that a lot of networking takes place "off pitch and it's not necessarily very visible", a possible example of virtual "buzz" (Bathelt and Turi, 2011). A few developers had co-located in the Waterloo area, and organised "Cyber Chats" with customers and sponsors. Another development company CEO differentiated themselves from the marketing units of Shoreditch, explaining,

> *So we have a common discussion around cyber that doesn't look like it's just a vendor conversation. We want the government to be involved and we want customers to be involved.*

Furthermore, surprisingly, unlike the vendors, he believed cyber-networking events were prolific in London, stating, “that in London there is probably a cyber round table happening almost every evening, but not so much in the pubs”.

It could be that this mixed response to face-to-face interactivity reflects the differences between the business operations of the interviewed firms. In addition, like the games cluster, cybersecurity in London is relatively young and, as Nathan and Vandore (2014) observed for the IT sector generally, until recently it has consisted of largely overseas vendor operations. They are likely to have little in common with each other or an interest in sharing knowledge because of the associated client confidentiality needs. As one cyber vendor explained, “[this] is an industry [where] you can go to prison if you get it wrong. You can be very heavily fined now and you know you can have a criminal conviction for not protecting people’s data”. Another CEO said, “no one wants to talk to each other, because they think it’s giving away to the competition”. The isolation of the cybersecurity worker is further compounded by niche sector diversity and skills specificity (described in Section 3.3.2). The same CEO explained that

> *interactivity is difficult because of the different areas of cybersecurity. You’ve got different segments of people at the end of different stages. Do they talk to each other? Probably not, if I’m honest.*

However, like for the London games industry, the same interviewee observed that things were changing, becoming more “relationship driven”, and “necessarily face-to-face”. He said,

> [cybersecurity is a] *trust and sensitive based industry, and things are changing… to a kind of “let’s create a culture that people enjoy working in”… it’s no longer the case that no one’s talking to each other, and no one’s interested in interacting with each other and it’s not just about the Official Secrets Act, but more work on personal PCs* [and] *on mobile phones… and, you know, that’s a whole different ball game.*

So the importance of “trust” is also increasingly being recognised by the cybersecurity firms, as it was for London games firms, but at the same time evolutionary trends are niche sector–specific. The social interactivity between cybersecurity companies may be increasing, in line with industry change and the growth of the UK industry, as well as general attitudes to business. The literature recognises that community social capital (of which “trust” is key) is likely to increase over time, and can thus be considered a benchmark of cluster evolution (Denicolai et al., 2010).

Whilst the pub did not seem to feature as a venue for informal networking, the survey showed that London offers other possibilities, including events, firm-sponsored networking opportunities

and traditional clubs. London hosts by far the most cybersecurity events globally. Between July until the end of 2019, thirty-five events were scheduled on the online event booking system Eventbrite, as shown in Figure 5.3:

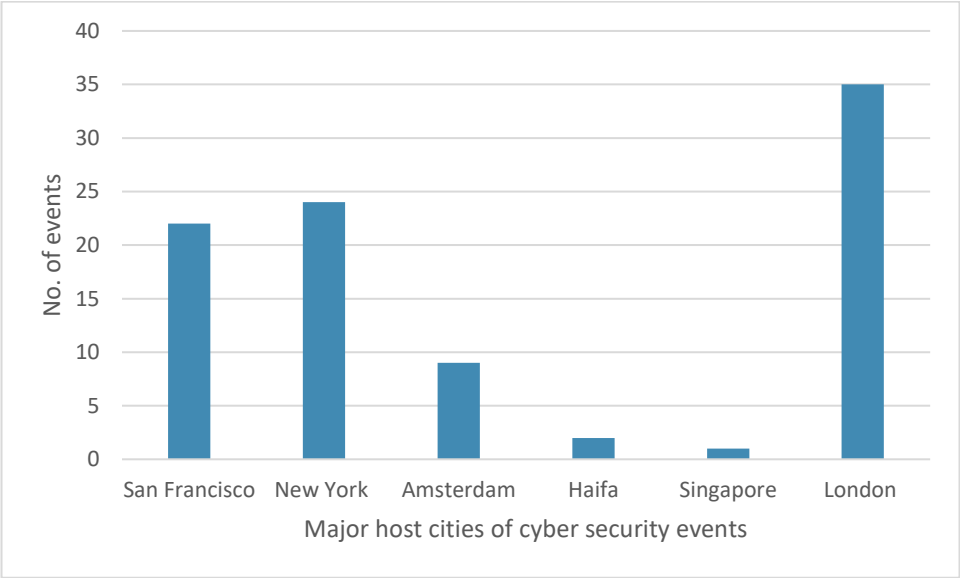


Figure 5.3 Cybersecurity events in global cyber hubs July 2019–Jan 2020

Source: Eventbrite

Traditional London clubs were used by an otherwise remote freelancer, who described his Club as "a place where [he] can comfortably host a meeting with a potential client". More recently, spotting a gap in the market for more networking events in 2017, and noticing the growing number of cybersecurity start-ups in London needing technological and legal information in particular, he has started up an organisation distributing learning videos and organising physical meet-ups in sponsoring cybersecurity offices every quarter.

Central to this cluster are the marketing offices of cybersecurity developers which are based elsewhere. They are dependent on customer-related primary knowledge flows. There is little evidence of local niche sector face-to-face interactivity, again due to a melange of factors including a culture of secrecy and a diverse skills base. In terms of the built environment, there are two key lessons: firstly, that the convenient flexible working spaces which suited the remote working practices of these firms were shown to be ineffective in terms of facilitating face-to-face interactivity, which is in contrast to the literature (for example Merkel, 2015; Capdevila, 2014; Madaleno et al., 2018); and secondly, how the firms enjoyed the tech-imbued local bars and restaurants, treating them as extended offices where they could meet clients. This finding adds nuance to the literature on "buzz" (Storper, 2013; Nathan and Vandore, 2014) and extended workplaces (Martins, 2015), and adds further granularity to our understanding of knowledge

communities. Like the London games cluster, there are indications of changing working patterns which add weight to the need to take an evolutionary approach to cluster studies.

5.2.4 The Malvern cybersecurity cluster

Overall, unlike the London cybersecurity companies which are generally the marketing and servicing part of organisations, the Malvern cybersecurity companies focus on development. The companies grow incrementally and employ highly qualified professionals with niche digital skills. Most of the firms have only one office and, the same as for their London based peers, their primary recognised need for knowledge relates to client-serving needs and product development. This means they struggle in terms of their relative isolation and poor transport connectivity. It is about thirty minutes' drive from Malvern to Worcester, with its motorway connection and fast train service (Figure 5.4). The local road network is, in the words of another CEO, "awful" and "horrific… they jam up all the time".

Figure 5.4 Malvern's location relative to the UK motorway network

Source: Google Maps

Most of their clients are based in metropolitan cities, both in the UK and overseas, which means that they are not so easily serviced from Malvern. One CEO of a larger development company put it, "but I'm not just around the corner. It's not as though I can meet in the local coffee shop with the head of security you know". Not only are train links slow, but airports are distant, as another CEO explained, whilst

> *tools for conferencing and so on are fantastic, they actually allow you to deliver products globally. But you know you've got to have an airport and be able to jump on a plane to go to New York or wherever. And that's highly problematic for this part of the world. Do I go?*

A solution for at least two of the interviewees was the opening of new offices in the US where most of their customers were located, providing further evidence of global pipelines (Bathelt et al., 2004).

For most firms interviewed, transportation connectivity was their most pressing problem, exacerbated by the fact that, as pointed out by one CEO, that there are few local customers. He pointedly mentioned that neither QinetiQ in Malvern nor GCHQ in Cheltenham has fostered supply chain linkages with local companies. This remoteness from customers, he felt, worked against their competitiveness in that product validation was difficult. The CEO went on to explain that

> *you need to validate your concept, you need to know there is customer demand for it, and they can be part of the process of the development. The cluster is a fundamental part of the process because they qualify and confirm that your idea is commercially valid. Because you can come up with the most wonderful gizmo and everyone would go whoa, that's clever, but if it doesn't solve a real-world problem that people are prepared to pay money for, you know, a wonderful piece of engineering. You know it's that "Concorde moment", when they build a fantastic plane. It's a kind of world-class piece of engineering that no one wanted.*

This scenario might well be common for many rural clusters, and would be a valuable focus for the under-researched area of rural/provincial clusters.

Aside from the issues of market connectivity, the interview survey revealed an appetite for secondary forms of knowledge in terms of both face-to-face technological and general business knowledge exchange and support. However, the extent to which this happens is open to question. Several businesses described how useful and supportive the local cyber-based community was. A micro-enterprise CEO said, "There is definitely a community that I have reached out to. There is certainly a community built up around and it is centred on Malvern and around the business park." A CEO of a relocated MNE said, "Dropping into, if you like a ready- made IT tech hub is an incredibly valuable process for a company like us." There was also evidence of inter-firm collaboration: "The relationships we have built up with others in the cyber cluster [have] helped to establish ourselves and promote us" (CEO, SME). Other, more established businesses described

how they enjoyed exchanging technical knowledge, and networking opportunities: “I’m interested in hearing about what work everyone’s doing and what technology they’re developing and where they’re going.” They “enjoy discussing their latest gizmo”, in “a boys club” (there was a notable lack of women in the interviewed firms), with a “lingua franca”. Such technological-based camaraderie sounds like the ideas of Marshall (1890), and the idea of sharing tacit knowledge within industrial districts, and also his Third Italy disciples (for example, Bagnasco, 1977; Becattini, 1987, 1990; Brusco, 1982 (in Vorley, 2008)), which emphasised the importance of the development and integration of local culture and society as a basis for a successful local economy. But this information sharing is less about finding new business opportunities, and rather more about developing a supportive community – a fact which was not apparent in the London examples, nor perhaps in competitive Guildford. At least half of the interviewees would be keen on more information sharing and interactivity. As another CEO said, “You can’t always help but you can say like, oh, there’s this new yammer, and both of you can work it out. I think more information sharing opportunities would help a lot more.”

There was little evidence in this study of niche sector face-to-face informal networking. There was, however, evidence of more micro groups developing and interacting virtually and face-to-face. One start-up founder was trying to network locally with a local Open Web Application Security Project (OWASP) community, “a free open software community which publishes the top ten vulnerabilities every year that sets a kind of standard”, whilst a CEO of a larger company observed that Malvern was “actually a little hotspot for voice biometric companies and professionals living locally and meeting in the same pub”. These observations reinforce the idea that technical commonalities are required for buzz and virtual buzz to operate effectively (Bathelt and Turi, 2011). Face-to-face meet-ups seemed generally to take place at events, which are numerous. As described by a CEO of a SME:

> *There are a lot of events, where even though there may not be any business out there, there’s certainly an environment for sharing knowledge, you know, these are the projects that are currently going on and this is where X department is looking at the future, and occasionally we get visits from delegations that come over from various places. Sometimes they’re useful, sometimes they’re not, but it’s more about the relationships and connections that we can make, rather than the businesses that we get from it.*

However, overall, local face-to-face interactivity seemed to be frustrated and local networking weak. Two cybersecurity entrepreneurs set up the “cybersecurity cluster forum”, a regular networking event which took place in the Wyche Innovation Centre, yet whilst the idea has

spread throughout the country, the Malvern "Cluster" meetings have been disbanded. Suggestions for the reasons for this include the transport situation and the lack of shared interests and skillsets. A small company CEO said, "There's such a wide differentiation of things that other people are doing, that quite often there isn't an overlap between what they're trying to do."

In addition the issue of secrecy was evident. Behind the apparent openness of the interviewed firms there was an impression of a culture of secrecy. There were, for example, firms who would not contemplate being interviewed because of the "nature of their business", and one interviewee, another small company CEO, explained the effect of the competitiveness of the product development process and how, "in the cyber industry you'll find that it is very secretive. People don't want anyone to get the idea and then get it out before them." However there was also evidence, as in London, of a changing culture, and as one interviewee pointed out, "what we see is simply a hangover from the days of working on sensitive projects for the Government". Also, some of the spin-out firms are now maturing and starting to take on a caretaker role recognised in the other case studies, promoting collaboration and community support. A CEO of an older firm recognised their role in developing the community:

> *When we find out about something and we already know someone else has got a problem with that, we can connect them together. There isn't any business that we get out of it, but one of the things we do get out of it is that the people remember us and when they find the need or one of their contacts find something we can fulfil, hopefully – but it's not expected – hopefully they will connect us.*

This community caretaker role observation which develops over time is interesting and may add to the literature on cluster evolutionary traits (for example Cooke and de Laurentis, 2010; Malmberg and Maskell, 2010).

On top of all these explanations for the perceived relatively low levels of face-to-face interactivity is the impact of the local built environment. Aside from the poor transport linkages, there are relatively few local bars and restaurants, only forty-five in and around Malvern town centre, equating to only 2.25 per known cybersecurity business – the lowest ratio in the study. The Wyche Innovation Centre provides a hub for start-up entrepreneurs and associated valuable interactive space, but it is removed from the town centre, as is the popular Malvern Hills Science Park. As described in the literature, start-up and collaborative workspaces can be valuable information sharing spaces, particularly for entrepreneurs, and they operate most effectively in geographical proximity and centrally positioned in the hub of a cluster's territory (Madaleno et al., 2018). This proximity is missing in Malvern. In addition, the design of the main workspaces in the

Malvern Hills Science Park, where most cybersecurity firms are located (see Chapter 4), appears to be unconducive to face-to-face interactivity. One founder based in the Science Park said,

> *As many companies are based in central Malvern, and because we're in the same sort of world, we do occasionally bump into each other and have a chat and talk about how we should do something, and have you talked to so-and-so. That the kind of thing that happens.* [It] *is not necessarily being in this building but being around this area with GCHQ down the road.*

A CEO of a larger company also based in the Science Park said,

> *It's a private place; it's got gates and barbed wire around, that kind of thing, so it's not conducive to creativity. It is very conducive to implementation and studious-type activities and solving the deep conundrums which are at the heart of many of these scientific processes.*

He likened it to a university campus or a library, but without the cultural facilities to "drive up the creative juices". He thought a better model would be something like the co-working space model of "Wework", a place which is more

> *community based, very coffee shop–based, where disparate people bump into each other with crazy ideas which they can bounce off each other. There could be a pitching session where everyone jumps up for five minutes and tells everyone.*

Figure 5.5 Entrance to stage 3 of the Malvern Hills Science Park

Source: https://www.ascertaintox.com/en/home/about.html

These observations accord with some of the recent literature which has recognised that most Science Parks reflect the design ideas of a previous era, "spatially isolated corporate campuses,

accessible only by car, that put little emphasis on quality of place" (Minguillo et al., 2015), when there were strong ideas about "closed innovation systems… where ideas were guarded and secrecy prized" (Katz and Bradley, 2013: 116). Madaleno et al. (2018) also point out that there is evidence that spillover effects may die away rapidly in science parks. Perhaps it is time for a new vision and design features to support face-to-face interactivity in the Malvern Science Park. Perhaps Florida's (2002) ideas about creative living might equally be applied to the more technological sector, in which creativity should, after all, be central to all business processes (for example Kao, 1997; Lehrer, 2012).

This was an exploration of a cluster showing relatively weak local face-to-face interactive activity and frustrated global connectivity with their primary relationship with their clients due to relative isolation and poor transport connectivity. In Malvern weak interactivity seems to relate to the diverse skills base and a secretive culture. There was a yearning for a more supportive community and informal local connectivity, yet efforts have been frustrated by the spread of workplaces, poor road connectivity and the non-collaborative design features of the Science Park. These observations add to literature relating to collaborative building design (for example Madaleno et al., 2018; Brydges and Hracs, 2019b), and integrative urban planning methodologies (for example Jacobs, 1992; Goodspeed, 2016). As for the other case studies, it was clear that the temporal dimension was important, and there were signs of an increasing openness and growing specialisms within the sector which a simple snapshot investigation cannot capture. These evolutionary trends are explored further in Chapter 6.

5.3 Reflections on the outputs

The case studies demonstrate how the combination of firm working practices and local built-environmental characteristics influence the amount of face-to-face interactivity that is ongoing in each cluster. The findings are summarised in Table 5.3.

Cluster	Key niche sector characteristics affecting levels of face-to-face interactivity	Strength of cluster-related face-to-face interactivity	Primary face-to-face interactivity and associated knowledge flows	Other forms of face-to-face interactivity and knowledge flows	Usual meeting places
Guildford Games	Project-based Very volatile Reliant on quickly expanding skilled teams Live/work culture, late hours	Highly interactive	Employment related	Business and technical support and knowhow Some cross-cluster linkages	Shared workspaces Pubs In the general neighbourhood Events
London Games	Remote working practices Commuting life style Key relationship with publishers and VCs	Low levels of inter-cluster interactivity Possibly evolving	Mixed: Publisher and VCs	Business support information for young companies	Publisher and VC offices Shared spaces Events
Malvern cybersecurity	Client servicing model Secret culture Broad skills base and lack of commonalities	Low levels of interactivity	Client servicing	Business and technical support and knowhow	Client office (distant) Shared start-up space Events
London cybersecurity	Client servicing Culture of sensitivity and security Broad skills base and lack of commonalities Remote working practices	Strongly connected to clients. Low levels of intra-cluster interactivity Possibly evolving	Client servicing	Business support information	Client offices Local restaurants and bars Events

Table 5.3 Summary table relating business models and working practices to face-to-face interactivity and firm built environments

The table highlights the variation of levels of face-to-face interactivity, the venues where this interactivity took place, and the nature of the knowledge being exchanged. Knowledge flows are distinguished between “primary” and “other”. “Primary” relates to essential industry information, which is central to the reasons for co-location, “employment”-related in Guildford and “client”-servicing in Shoreditch. The “other” forms of knowledge, whilst not so obvious, are a result of co-location, yet were perceived as being important by all interviewees. Identifiable “other” forms of knowledge generally related to technical knowhow, business support, and property market information, each recognisable for an element of tacticity, which can be better transmitted through face-to-face means (Polanyi, 1966; Balconi, 2002; Gertler, 2003).

The table assists with answering the research questions.

5.3.1 The effect of business working practices on the need for local face-to-face knowledge?

The information needs of the two niche sectors are strikingly differentiated by their core business models, and associated working practices. The games firms reach their customers through the world wide web, whereas cybersecurity products and services are shaped for bespoke customer usage, relying on a trusting relationship facilitated through face-to-face interactivity. This difference has consequential built environmental implications. The games companies seemingly could locate anywhere, whereas for the cybersecurity companies, geographic proximity to their clients is all-important.

The second key differentiator, based on a common reliance on skilled human resources, relates to the varying urgency for these skills. The Guildford indie games firms and professionals rely on the fast turnaround of employment-related information, operating on a high-risk project-by-project basis. Their business models necessitate them being a part of the churning interconnected pool of labour, and in the "thick of things". This is much along the lines of an industrial district (Marshall, 1885) and the games industry "project ecology" type model described by Vallance (2013), with a strong live/work ethic, much in the way described in case studies of the creative sector in general (Florida, 2002). Conversely, the mobile games companies based around Clerkenwell in London are generally non-indie developers, less exposed to risk and the "boom and bust" model, with smaller project teams, which means that their employment requirements and related information flows tend to be relatively smaller and less urgent. Talent is naturally attracted to London, and social media fulfils their employment information requirements. Overall, the impression was that face-to-face meetings and knowledge flows are of less importance than in Guildford, with some larger businesses actively seeking to avoid physical contact and exposing themselves to labour poaching. Cybersecurity companies in the two case studies also showed differences based on their position in the value chain, with strong connectivity with clients, but weaker inter-firm interactivity. Malvern firms rely on an extremely niche skillset, and talent is attracted by the very niche nature of and interest in the work, whereas Shoreditch firms are more varied and service orientated, the skills more available, and facilitated through social media and virtual "buzz" like for the games companies in globally attractive London. Virtual "buzz", recognised by Bathelt and Turi (2011), may be more of a reflection of metropolitan niche sectors. An interesting further study would be to investigate how well niche sectors are represented in these social media groups, and the associated levels of interactivity. The generally weaker physical connectivity of the London clusters reflects the findings of studies of the tech industry in general for the Tech City district of

East London (Nathan and Vandore, 2014) and the software cluster of Oslo (Isaksen, 2004), also both based in metropolises, albeit that neither study picked up on any built environmental aspects of these localities.

It was notable that all interviewees saw a value in localised face-to-face interactivity. Whilst there were indications of generally more open cultures developing in all cases, the biggest determinate seemed to be business life-cycle stage, much in the manner described in classic works by Perroux (1955) and Porter (1990). Young firms especially appreciated the ability to tap into a supportive business community, and all professionals enjoyed exchanging technical knowhow, with examples in both niche sectors of the need to validate products. The exchange and importance of property market information is developed in the next chapter. As the firms matured, there was evidence of a desire to meet like-minded professionals and foster a sense of community, with examples of firms in each case taking on this role by offering networking opportunities and staging events. This mentoring and community role is an interesting observation, little recognised in other cluster case studies.

The firms had different and mixed reasons to be associated with a “buzzing” neighbourhood. Clearly the primary information needs of Guildford and Shoreditch firms were very easily transmitted in local restaurants and bars, and all firms valued local “buzz” in terms of identifying with a specialist community, and its associated attractiveness for hard-won employees. Local “buzz” also supported more subtle cultural, technological and creative information flows, which firms in London especially fed off. These are good examples of the “feel good” value added, of Jacobean, cross-cluster linkages (see Section 2.2.3), much as described in other works on creative milieux (for example Florida, 2002; Champion, 2010). Evidence of resultant innovation in the manner anticipated in the classic clustering studies of Porter (1990) and Jacobs (1969) was only evident in Guildford, through inter-cluster connectivity between games firms and the local car industry. Local “buzz” was often about being in the “thick of things” (Guildford games CEO), and in the words of one founder of a cybersecurity SME, being interested in the nebulous concept of “what's going on”. This appeal for the supportive benefits of a technical community from many interviewees across all clusters has perhaps has been overlooked in the recent literature, despite its recognition in the Industrial District models (for example Marshall, 1890, and the later Third Italy work, including Bagnasco, 1977; Becattini, 1987, 1990; Brusco, 1992; and Vorley, 2008).

It is proposed that the studies which look at the creative sector (for example Florida, 2002 and Champion, 2010) have missed the granularity of the industry and associated geography of “buzz”. The niche-sector lens of investigation is highly relevant, adding to a small but growing evidence

base seeking to understand the dynamics and role of local "buzz", including studies on London's design industry (Sunley et al., 2010); new media (Pratt, 2013); and advertising (Clare, 2013).

5.3.2 The effect of the local built environments on local face-to-face interactivity .

This section probes how well the local built environment affords or constrains the local knowledge flow needs of cluster firms, and whether the firms are taking adaptive measures to meet their knowledge flow needs. Table 5.4 below summarises for each case study the affordances and constraints of each local built environment in terms of meeting local face-to-face interactivity needs, and any adaptive measures taken where there is a gap in knowledge flow needs.

Cluster	Local built environment assets affording face-to-face interactivity	Local built environmental constraints to face-to-face interactivity	Adaptive measures to meet knowledge-flow needs
Guildford games	Shared games start-up space Density of built form Easy access to fast train line Town centre social outlets Events	Distance of start-up space from town centre	Cramming into the town centre
London games	Home working Sharing of built space with peer companies for young companies Local, regional and international transport communications proximity to creative /cultural scene Access to international status events	Lack of start-up space Relative spread of workplaces	Home working Social media for employment purposes UKIE central games hub
Malvern cybersecurity	Cybersecurity start-up space	Poor road, rail and airport connectivity Isolation from town centre social outlets Design of Malvern Hills Science Park	Development of cluster forum meetings Development of very niche social media groupings
London cybersecurity	Flexible working spaces provide for flexible working Local social outlets for client and marketing meetings.	No niche sector hub No start-up space Spread of workplaces and spaces	Remote working Older firms starting networking breakfasts Evidence of niche sector networking organisation development

Table 5.4 Case study built environmental affordances, constraints and adaptions

In all the case studies, the built environments have been facilitative towards local face-to-face interactivity to some degree, albeit there are clearly issues in some cases. Bespoke niche sector

start-up spaces assist entrepreneurs with access to business support information in Guildford and Malvern, but not in London. Noticeably both spaces are remote from the main cluster hubs, and it is found that the businesses seek to relocate centrally as soon as they able or require the extra space. In London, it is likely that a start-up hub would assist early-stage interactivity for each niche sector, with the observed added benefits of heightening cluster conspicuousness. The supportive interactivity and information needs of firms facing the sensitive "move-on" stage, were well served through sharing workspaces in Guildford. Workplace and workspace design and form were shown to have a direct on firms in the Malvern Hills Science Park, making it unconducive to face-to-face interactivity, in the manner of many science parks as described by Madeleno et al. (2018). Common to each stage of the business life-cycle was the role of events, which were shown to provide opportunities to connect with peers, observe the competition, and top up with technical knowledge.

The Guildford and Shoreditch explorations suggest that proximate restaurants and bars form part of the extended workplace of the games and cybersecurity firms respectively (Martins, 2015). They provide both formal and informal meeting places with like-minded professionals, places which are well adapted for the effective relaying of employment and customer information respectively. As described in the previous section, London firms enjoy the local "buzz", but serendipitous niche-sector linkages are frustrated by the heterogeneity of the local economy and its relative spread. Similar factors of relative isolation are also partly responsible for a lack of local "buzz" associated with the Malvern cluster.

Not only is a portfolio of appropriate forms of workspace necessary for an expanding cluster (see Section 4.3.2, and Segal Quince Wicksteed, 1985) but it needs to be accompanied by meet-up spaces within a zone of effectiveness around the workspace. This study recognises a typology of such spaces, namely same-sector shared workplaces, a same-sector localised density of workplaces, local social outlets, good public transport linkages, and professional events. Their presence in each of the case-study clusters is indicated by an X in Table 5.5:

	Same-sector sharing workplaces	Same-sector localised density of workspaces	Local social outlets	Good public transport linkages	Professional events
Guildford games	X	X	X	X	X
Clerkenwell games	X		X	X	X
Shoreditch cybersecurity		X	X	X	X
Malvern cybersecurity	X				X

Table 5.5 Typology of local face-to-face interactive spaces by case study

These built-environmental features might be considered integral to business operations and viewed as a form of workplace extension, much in the manner described by Martins (2014), but they take Martins's work one step further in that their presence is shown to be integral to the sustainability of a niche-sector cluster.

It does appear that where facilitative interactivity spaces are lacking, there is evidence of adaptive measures being taken by firms and their niche sector communities (Table 5.4). The bespoke start-up spaces of Guildford and Malvern were both the result of an industry recognition of the need for shared supportive space for entrepreneurs. Similarly, the industry-led development of UKIE as a central networking hub has benefited the games cluster of Clerkenwell. The London cybersecurity cluster now has a bespoke cybersecurity shared workplace, created by the firm Digital Shadows. All these initiatives support same-sector interaction, with the added advantage of creating much-needed, conspicuous niche sector–related hubs, which reinforce the developing niche sector association with place (Section 4.3.1). The key seems to be the bespoke nature of each initiative, and the need to have niche sector–based collaborative spaces, which foster interactivity due to overlapping professional commonalities. This insight adds to our ideas of how flexible workspaces may best operate (for example Capdevila, 2014; Madalino et al., 2018).

Other adaptive mechanisms relate to networking events, the responsibility for which has often been taken on by the larger, more mature companies in the clusters, or an evolving collection of facilitative organisations. What appears to be the common process is that a cluster needs to grow to a certain size, with a density of built form and level of maturity, before local face-to-face interactivity can take off, as demonstrated by the failure of the Malvern Cluster initiative. The need for physical interactivity was recognised, but the built environment could not support it. These observations add to cluster evolutionary process insights and the literature on cluster evolution (for example Huggins, 2008), which will be developed in the next chapter.

Whilst social media can and does fill the gaps in flows of knowledge, often it appears that face-to-face interactivity is preferred, especially in respect of the flow of “primary” knowledge, which supports the ideas of trust being implicit to physical meet-ups. Equally, face-to-face “other” knowledge flows are valued, but are shown to be the consequence of interactivity afforded through co-location and meet-up opportunities. It would seem that “virtual buzz” is complementary to “local buzz”, helping to fill the gaps in interactivity. It would be interesting to know how “place-based” the virtual networks are, and to what extent they overlap with the location of the physical cluster. It could be that a cluster may have a physical presence and a contiguous or wider virtual presence, an idea touched upon in research by Pratt (2000) and Grabher and Ibert (2014).

These observations add nuance and transferable evidence on the ubiquitous value of general business support information, technical know-how and a more ephemeral sense of community, to clustering firms and how a lack of these forms of information spill overs may be being frustrated by built environmental factors.

5.4 Conclusions and contributions to the literature

Local face-to-face interactivity has been found to be important, but to differing degrees in each cluster, due to a combination of factors, niche sector business model variations, working practices and cultures, the maturity of the respective clusters, and the nature of their built environments. It is proposed that this combination of variables produces a unique “brew” and symbiosis of social interactivity and built form. The findings support Clare’s observations of the advertising cluster of Soho which similarly showed that there must be a certain social density facilitated by the built environment, which enables “the random entwinements of lives in an urban milieu”, (Clare 2013: 55). Reflecting Martin’s (2015) work, this study found that useful face-to-face business meetings take place within very short distances of the workplace, and are unlikely to be serendipitous, as professionals prefer the company of like professionals. There needs to be an associated high density of built form (Jacobs, 1969), complemented by a trusting and personally connected working population. This observation is borne out by the weak levels of general interactivity in London and Malvern, and the conversely fully functioning labour pool mechanism of Guildford. Contrary to the ideas of Wagner and Sternberg (2004), who were reluctant to endorse the effectiveness of rural clusters, and the generally metropolitan-biased cluster literature, the study provides evidence that provincial clusters can operate more effectively than their metropolitan counterparts, provided that the right balance of ingredients is in place.

The exploration contributes to the debates on local “buzz”, showing that it is complex and very granular, with a variety of purposes including knowledge exchange, community development, and (very importantly) an associated credibility and place-making function. Social media and a place-based virtual cluster are shown to support and fill the gaps in the local interactivity activities of a cluster. These observations feed into the discussion surrounding both “buzz” and “virtual buzz”, showing that the two are complementary, albeit that physical interactivity is preferred for important urgent or trust based relationships (Storper and Venables, 2004; Stam, 2010).

The study has identified characteristics and attributes of the built environment which support the generally valued activity of localised face-to-face interaction. Furthermore, it has highlighted perhaps for the first time, the evolutionary aspects of local interactivity, the role played by more mature firms or cluster champions in setting up networking operations. These developments seem to be successful once the cluster has reached a certain critical size, density and level of maturity. The examples suggest that clustering business actors are mindful of their needs and may be best placed to guide this form of cluster development intervention. Some of these evolutionary aspects of cluster development are developed in the following chapter.

Chapter 6 The interplay between digital technology clusters and their local property markets

6.1 Introduction

The previous research chapters have explored co-location and local face-to-face interactivity in the case study clusters. They also looked at the respective adaptive behaviours of the firms, which indicated that both the clusters and the property market element of the built environment are in constant flux, which it is argued may implicate cluster growth and development. In line with the research approach described in Section 3.2, this chapter seeks to develop this observation by exploring the third characteristic of clusters, their dynamism, and focuses on the interplay over time, of the developing clusters with the workspace property market.

Businesses rely on the availability of workspace. Workspace, as defined in Section 4.1, is the physical area of work. In property market terms, workspaces are generally recognised within the office market (which is a sub-market of the commercial, as opposed to the residential property market). A property market is defined as "the institutional arrangements through which real property is used, traded and developed, and the wide range of actors involved in these processes" (D'Arcy and Keogh, 1999: 917). Traditionally it has been assumed that demand for property is met by supply, (Lichfield and Darin-Drabkin, 1980). However it is clear, as described in Section 2.4.2.1, that the market is more nuanced and complex than this, reflecting an array of complicating and interdependent factors which this study explores, including the differential role of property market actors such as landowners, estate agents, developers, tenants, public and political bodies and their interrelationships (Massey, 1984), the existing built form and its degree of heterogeneity (Evans, 2004); information flows (Marshall, 1890; Evans, 2008), property values, law and other regulations, planning policy and urban policy (Glaeser and Ward, 2006; Healey, 2010; Theurillat et al., 2014; Osman, 2015), and the cyclical effect of the property market itself (Leitner, 1994; Keogh and D'Arcy, 1994; Key et al., 1994; Guy and Henneberry, 2004). These factors will be in a state of constant movement (Evans, 2004: 246). This dynamism is driven by changing demand patterns, overlaid by cyclical and lagging property market trends which are conventionally illustrated, as is the case in this study, by fluctuating variables such as stock levels, vacancy rates, rentals and uptake patterns (Ball et al., 1998). This exploration probes the localised cluster-related demand patterns and place-related supply variations in both time and space.

The investigation will also develop the observations of Chapters 4 and 5 in respect of the impact of land use planning on the local property markets, another literature gap requiring more investigation (Glaeser and Ward, 2006; Cheshire et al., 2014; Osman, 2015; Ploegmakers et al., 2017). It reflects on the flexibility of the local land planning institutions, relative to the dynamism of the case-study property markets and niche sector industries, and whether they are fit for purpose. Whilst the UK planning system is one of the most comprehensive in the world (Mayo and Sheppard, 2001), it has been much maligned for its inflexibility towards niche businesses due to its prioritisation of protective and conservation-orientated policies (Segal Quince Wicksteed, 1985: 11; Allmendinger, 2006; Overman, 2012; Hall et al., 1973; Gilg, 2005; Cheshire et al., 2012, 2014; Barker, 2016). However, as described in Section 4.3.2, there are contrary examples, where the same protective planning policies have worked to the advantage of creative clusters (Hutton, 2008; Scott, 2006; Mommaas, 2004; He and Gebhart, 2013). This study develops the evidence to inform this gap in the literature. The novel temporal element of this exploration will add a more dynamic perspective on the role of planning on both property markets and cluster development.

Central to this investigation, guided by the study's hypothesis (Section 2.5), is developing an understanding of how responsive or efficient local property markets are to the workspace needs of the local economy (Evans, 2004; Arvantidis, 2006, 2015). This is done through the presentation of four historical narratives in the next section, Section 6.2, each derived from the case studies. To my knowledge this is the first time a property market efficiency investigation has been applied to clusters. A non-responsive property market is often said to reflect a "market gap" (Jones, 1996; Evans, 2004), and can be due to a deficit or negative impact of any of the above factors.

6.2 Descriptions of the impact of local property markets on the case-study digital businesses

By way of context, it is useful to compare the local property markets of each of the case study areas prior to and during the time of the study (2018/19). Figure 6.1 charts average rental levels for each of the case study areas. It should be recognised that office sub-market data does not always coincide with cluster locations. Malvern data relates to the whole town rather than distinguishing between fringe and town centre markets, as is the case in Guildford. Clerkenwell is distinguished whereas Shoreditch is not. "City Fringe" figures are used to represent the market in Shoreditch. The implications of this are discussed in Section 6.3.2, and it is considered that they are sufficiently representative to be meaningful. It is noteworthy that London rental levels are at least three times Malvern levels and double Guildford levels. 2012–2016 saw rents rising in London by some 60%. Guildford rental rises were less pronounced, rising by 10% over the period

of 2011–2018. Conversely, Malvern rents decreased from 2009, reaching their lowest point in recent times, £10 per square foot, in 2015, a time when London rents had almost reached their peak of £53 per square foot. Clearly the London office markets command the highest rents and are far more dynamic and changeable than the non-London ones.

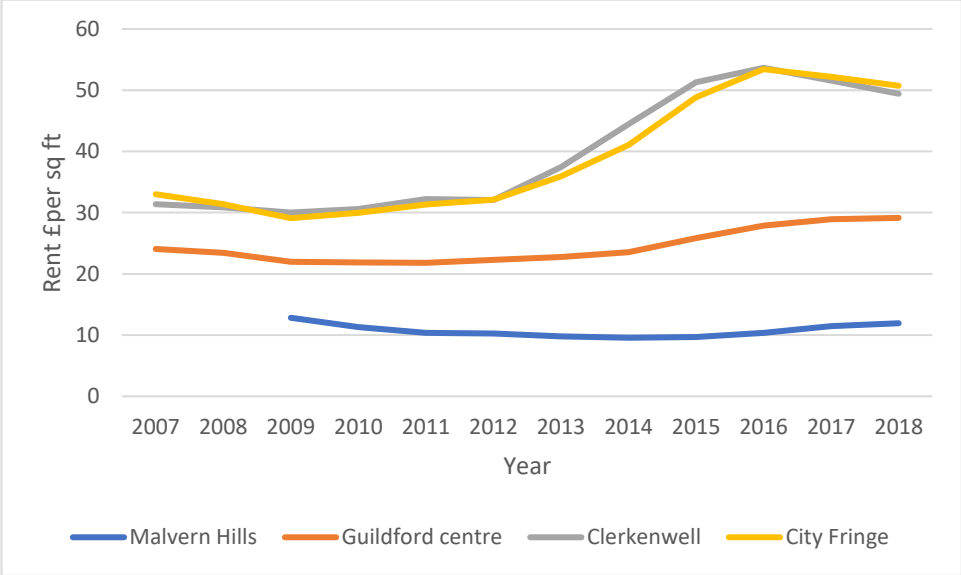


Figure 6.1 Comparison of average annual office rents for each case study

Source: Costar 12/2/2019

The literature explains that these differences reflect on the main drivers of the property markets. London markets are more aligned with the financial cycles than local markets, which, it is said, are likely to be much more finely tuned to local demand than these general trends show (Leitner, 1994; Keogh and D'Arcy, 1994; Key et al., 1994c; Guy and Henneberry, 2004).

Figure 6.2 charts annual rental growth rates over time, which typically is of interest to the property investment sector and will influence the interest in developing or refurbishing new workspace.

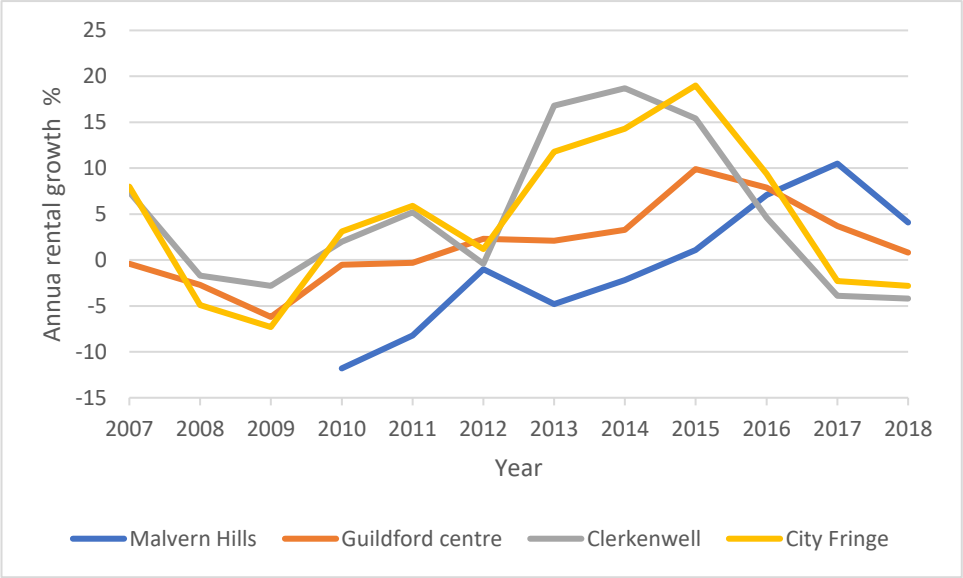


Figure 6.2 Comparison of average annual office rental growth for each case study office sub-market

Source: Costar 12/2/2019

Once again the differences in rental growth are apparent, with the London property market examples fluctuating widely, very much affected by the financial cycles, whilst Guildford and Malvern lag behind with more moderate movements of rental growth, which in Malvern Hills seems to take place a year or so later than the other property markets. The financial crash of 2008 is shown to have had a dramatic effect on all property markets: rental growth was negative for each property markets except Clerkenwell, with growth rates peaking 5–7 years later in London and Guildford, and later in Malvern – in 2017 – from a level at least 10% lower than for the other property markets. All property markets then headed into another downturn thereafter. The study period, 2018–2019, was one of a slowing down of growth, likely to be unattractive to investors and developers.

The following subsections examine the property markets in each case study and their interaction with the digital companies and cluster evolutionary patterns.

6.2.1 The Guildford games cluster

The Guildford games cluster has been growing since the late 1980s. The number of digital games company registrations in Guildford is shown over recent time in Figure 6.3.

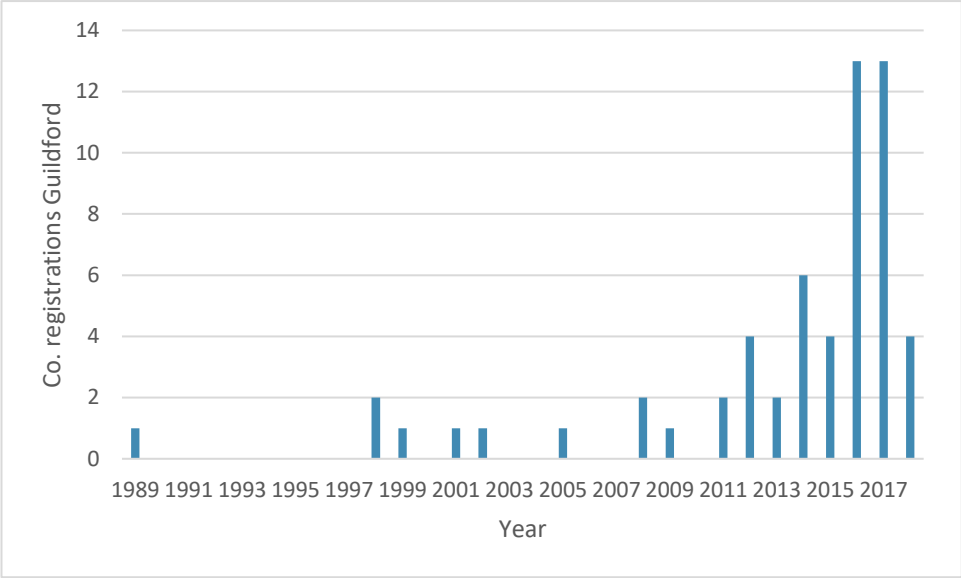


Figure 6.3 Games company registration in Guildford over time

Source: Companies House

Company registration figures started to rise conspicuously in 2014. In this year the government granted tax relief for creative technology companies, with the intention of encouraging the growth of the industry. The surge in company registrations in 2016/2017 is thought to relate to the closure of Lionhead studios (which were owned by Microsoft having bought out Bullfrog Games, the "mother" studio of the rest, and which had been started by Peter Molyneux and Les Edgar in the early 1980s), and the simultaneous release in 2016 of the Steam development platform, one of only two main platforms for games development (Section 3.3.2), which became a specialist niche for the Guildford industry (Section 3.3.1). The closure is said to have resulted in a large spin-out start-up community, which ties in with the above data.

Many entrepreneurs founded their companies at home, but within a couple of years would have to face the risky stage of taking on "move on" workspace (as described in Chapter 4). It is interesting to observe the changes in town centre office stock during the same period (Figure 6.4 below), and noteworthy that the peak of company registrations of 2016 and 2017 (Figure 6.3) corresponds with a trough in town centre floor area in 2016.

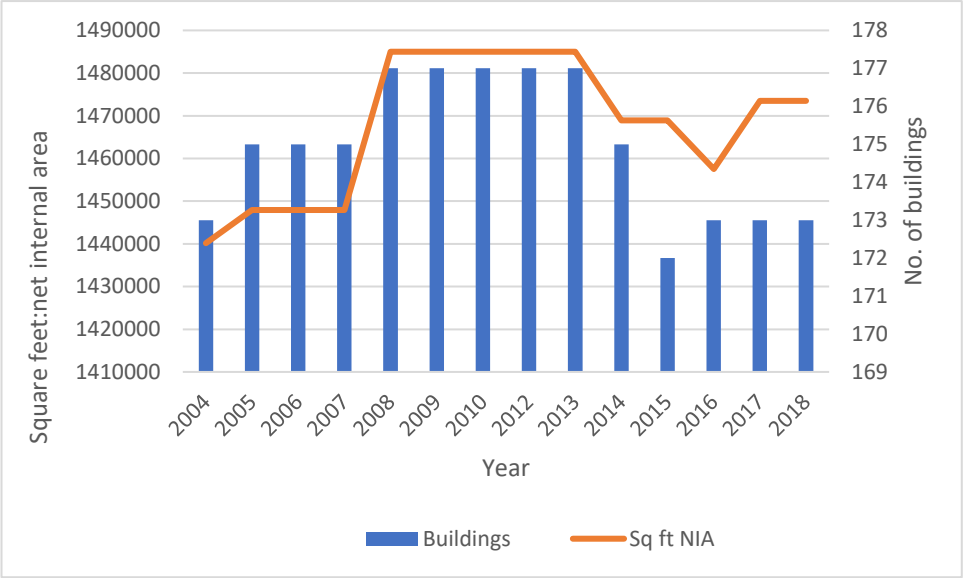


Figure 6.4 Guildford town centre total office stock over time

Source: Costar 12/2/2019

The rise in office space in 2008 relates to an increase in office building activity, a lag effect from the over-buoyant market of the early 2000s. In 2008/2009, the property market crashed and the economy fell into recession, which limited building activity, and is shown by the stabilisation of the amount of office stock between 2008–2013. The downward period from 2013, which coincided with the emergence of the games companies, was exacerbated through the implementation of changes to the Town and Country Planning (General Permitted Development (England)) Order in 2015, granting planning permission for the change of use of some business-use classes of building to residential through permitted development rights (described in detail in Section 5.2.1). Some 30,000 sq. ft of town centre office space was lost in this way.[27] As shown in Figure 6.5, the result was that office vacancy rates dropped at this time and rents started to rise steeply.

[27] Data from Table PDR1 Applications for prior approval by district planning authority: https://www.gov.uk/government/statistical-data-sets/live-tables-on-planning-application-statistics#permitted-development-rights-tables.

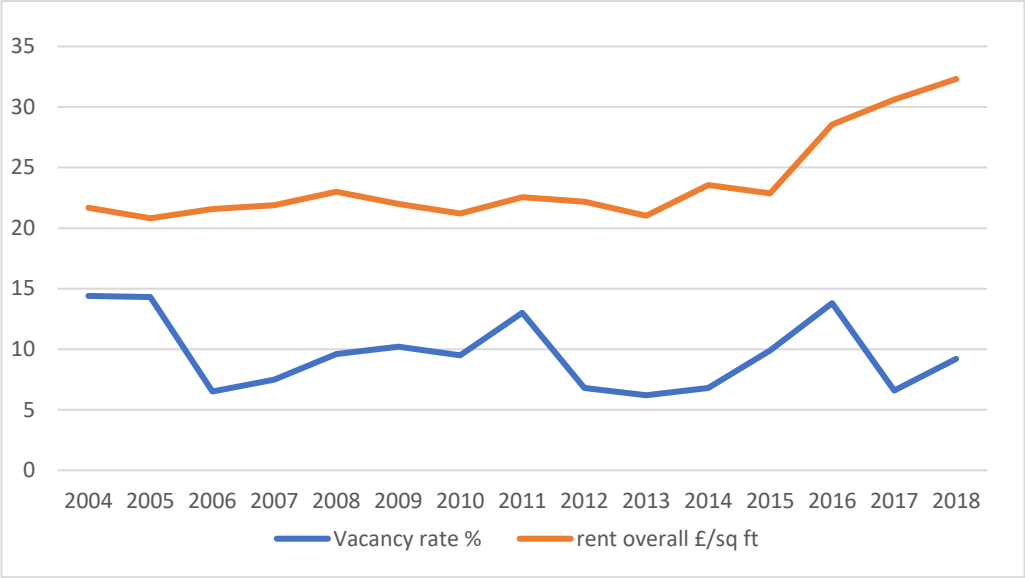


Figure 6.5 Guildford town centre annual office vacancy rates and rental levels

Source: Costar 12/2/2019

Thus, the surge in new games companies in 2015/2016 were companies "moving on" and maturing at a very lean time in terms of office supply. This might have blocked the growth of the cluster, if the town were not unusually fortunate to have a relatively large supply of small offices as described in Section 4.2.1. It boasts a sizeable stock of lower-grade small office space, in the form of ex-industrial space in Walnut Tree Close adjacent to the station. Walnut Tree Close (location as indicated in Figure 4.2) became a favoured location for games companies, which, through its industrial past and its susceptibility to flooding and traffic congestion, meant that it was not a popular location for other office or industrial tenants.

Figure 6.6 Semi-industrial buildings in Walnut Tree Close

Source: author

The games companies have enjoyed the workspaces offered in Walnut Tree Close, their low rents, flexible leases and proximity to the train station, together with the relatively small workspaces protected by planning policies within the town centre. Happily for the games sector, Guildford's other successful sectors did not compete for the same space: the "professional service industries", employing some 18,000 people in the town, preferred the top-end grade A space, which is located on the fringe of the town, whilst the "health, life sciences and pharmaceutical sector" locates itself in the contemporary office space of the Surrey Research Park, close to the university and the hospital (Guildford Borough Council Economic Strategy 2013–2031).

Since 1989, thirteen games firms have been registered as having an address in Walnut Tree Close, and today it is the home of at least four companies. Many companies have shared space with other companies, which has contributed to the recognised high levels of interactivity (described in Chapter 5) and undoubtedly contributed to "spreading the word" on available workspace. One interviewee described this phenomenon as a "snowball effect", which seems to replicate the ideas of cluster formation through a "chain of cumulative causation " (Malmberg and Maskell, 2010: 400), described in Section 2.5.2.5.1. The flow of property-related information has no doubt literally opened doors for all games companies, as they traverse the supply pipeline of workspace.

A further observation is that, according to a Google search, Guildford boasts some eighteen commercial estate agents, which undoubtedly add to the property-related information flows, communication of which is probably heighted due to competition between agents. The responsiveness of the property market to the demands of these fledgling companies has no doubt been assisted by the local built form, as described in Section 4.2.1. The relationship between the property market information flows and the sustainability of clusters would make a useful addition to the cluster literature, and is discussed further in Section 6.3.2. These observations are further supported by comparison of vacancy rates by property quality grade (Figure 6.7). The figure shows the decline of vacancy rates from 2014/2015 for the popular 1* and 2* properties, which are mostly to be found in the town centre. 2014/2015 is when the games cluster took off, and when the permitted development rights legislation came into force. The Council are thought to be considering implementing an Article 4 direction (Section 2.4.2) to stem the losses of office space, yet this is still to bear fruit. Their slow implementation of the direction caused a good deal of anger amongst some interviewees, who recognised the damaging effect that the permitted development rights had on office supply at a much-needed stage in their growth.

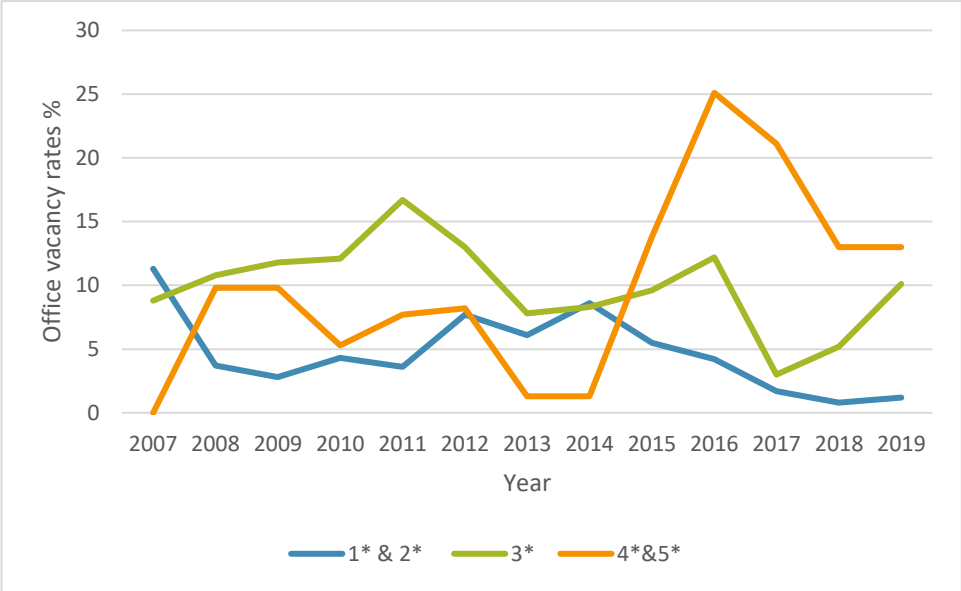


Figure 6.7 Guildford centre, annual office vacancy rates by quality of workspace

Source: Costar 12/2/2019

Since 2018, coincident with the maturation of many of the 2015/2016 games companies, there has been a gentle comeback in office supply of the higher grades in the town centre. Rents have risen in the 3* and 4/5* property sub-sectors, (see Figure 4.19), making refurbishment of the remaining office supply more cost effective, and leading to an increasing efficiency of the buildings and a resultant increase in net floorspace.

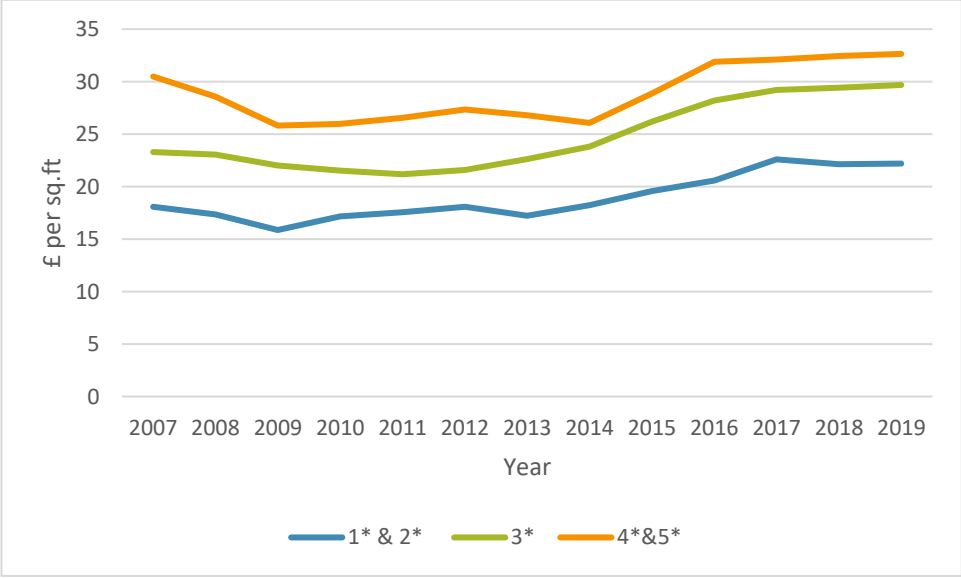


Figure 6.8 Guildford centre, annual average rental values by quality of workspace

Source: Costar 12/2/2019

Commercial agents noted the effect this surge in take up of space, suggesting that it was responsible for 40% of market activity in 2017 (Lambert Hampton Smith, 2017) and meant that

Guildford town centre performed relatively strongly compared to many town centres in the Thames Valley and southeast areas of the country.

The future is likely to pose more challenges for the growing games cluster. Not only is the supply of small low-grade offices becoming ever tighter (see Figure 6.18), but town centre workspaces are being converted for residential use, and a proposed redevelopment of Walnut Tree Close to student housing and other residential uses will, if it goes ahead, severely undermine the availability of "move on" workspace. One commercial agent was keenly aware of the issue and said that he has "88,000 sq. ft total space requirements for games companies which I am trying to satisfy". A consequence of the limited office supply is a rise in rental values. One medium-sized company CEO said, "Our problem is just the space. We can't find an office two to three times the size of this that doesn't require a ten-year lease." Another complained that, "we're absolutely haemorrhaging money on rent." These factors could potentially affect the sustainability of the cluster. However, another outcome of rental growth is the possibility of a market readjustment, supported by the perceived sustainable demand for space, and rapid and effective property market information flows, investors and developers are now interested in the town and the opportunities that the recognised games cluster offers. In an unprecedented development, two new speculative projects have been undertaken aimed at the games firm market: "River Works", a speculative office block; and the refurbishment of 255 High Street. Together they provide an extra 80,000 sq. ft of office space, boasting "exposed services" and an "urban, gritty" look in the manner preferred by the games companies (described in Section 4.2.1). In the words of one of the town's commercial property agents, "the developer and investor market would not have taken this step if they had not been convinced of the sustainability of the technological sector in Guildford." Whether these new workspaces will satisfactorily replace the old stock of the town centre, and especially Walnut Tree Close, is a question that remains to be answered.

The Guildford town centre commercial property market is a consummate example of the market responding, adapting and supporting a niche industry. The future for the Guildford games cluster is far from clear, albeit that the demonstrably high office market response rates and monopolistic town centre market combined with protectionist planning policies (see Chapter 5) may continue to work for the sector. It was suggested by a CEO of a key games company in the town that the industry demonstrates a seven-year cycle. At this moment in time, "there is currently an explosion of small businesses; many fail and then we will see a reconsolidation". Thereafter there could be another cycle of "boom and bust", much in the manner that occurred with the Microsoft takeover of Lionhead studios in 2006, and then its failure in 2016, with another rash of spillout companies being formed. Where this next cohort of small start-up companies would locate in Guildford is far from clear.

In summary, the section describes the dynamic relationship between the growth of the Guildford games cluster and the unusually large supply of appropriate, small, interesting workspace. Available cheap, semi-industrial space in Walnut Tree Close, within walking distance of the station, met the needs of the sensitive start-up and "move on" phases of the plethora of firms which spilt over following the closure of the Microsoft studios in 2015/16. Both industry and property market evolution are apparent, albeit there is evidence that developers have now started to understand the needs of the evolving games industry through bespoke speculative developments. A churning mix of firms and workspaces is described, held together through an effective web of property market information, which provides useful primary evidence to literature relating to the cumulative causation effects on cluster evolution (Malmberg and Maskell, 2010: 400). The impact of planning policy is again highlighted, and the lack of involvement of the planning authority by not implementing an Article 4 direction to stem the tide of workspace loss is shown to have led to a net loss of office stock. Yet the damage could have been worse, had the remaining stock not been protected by planning policies (Section 4.2.2). The study provides evidence adding to the debate on the effects of planning policy lock on industry change dynamics (for example, Needham and Low, 2006).

6.2.2 The Malvern cybersecurity cluster

The Malvern case study demonstrated a discernible link between the supply of office space and the growth of the cluster. It was not possible to identify cybersecurity firms through Companies House data, due to definitional problems, however an historical narrative has been pieced together from interview material and is reproduced in Table 6.1 below. The companies are anonymised. The table charts significant dates in the emergence of the cluster through the establishment of spin-off companies from QinetiQ, growth of which has been enabled through the provision of workspace in the Wyche Innovation Centre and the Malvern Science Park.

Significant built environment developments	Significant non–built environment developments	Year	Start-up space	Relocation
Malvern Hills Science Park (MHSP) innovation centre opens		1999		
		2000		
MHSP Regional Technology Exchange opens	Included funding support	2001		
		2002	Company start-up A takes space in MHSP	

Significant built environment developments	Significant non–built environment developments	Year	Start-up space	Relocation
		2003	Company start-up B takes space in MHSP	
		2004		
		2005	Company start-up C takes space in MHSP	
		2006	Company start-up D takes space in MHSP	
Property market goes into recession	iPad launched. Increasing use of personal telecommunications	2007		
Opening of Phase 3 MHSP including labs and cafe		2008		
		2009	Company E moves into Enigma Business Park	
	Loss of 230 jobs at QinetiQ	2010	Company F starts at home in Malvern	
	Loss of 50 jobs at QinetiQ Worcestershire LEP formed. Start of cybersecurity industry promotion	2011	Company start-up G starts, based in Worcester home	
Opening of Wyche Innovation Centre (WIC)		2012	Company start-up H is based in WIC	Company H moves to MHSP Company E and F move to WIC
		2013	Company start-up I is based in WIC	
		2014		Company I moves to MHSP
		2015	Company J is based in WIC	Company G moves to freehold premises
		2016	Company start-up K is based at home in Malvern Start-up L is based at home in Malvern	
		2017	Company start-up M locates in WIC	
	Loss of 75 jobs at QinetiQ	2018	Company start-up N is based at home in Worcester	
		2019		Company O relocates from overseas to MHSP

Table 6.1 Timeline for the Malvern cybersecurity cluster

MHSP: Malvern Hills Science Park. WIC: Wyche Innovation Centre

Table 6.1 shows how there was a rash of start-up companies founded from 2002, probably the result of a number of factors including the increased use of mobile technology; the rationalisation of DERA[28] and changes in QinetiQ which is based in the town, drawing many cybersecurity professionals to the area. In 1999, the Malvern Hills Science Park was completed and opened its doors to scientific businesses. The Science Park was set up originally with a view to providing office space for spin-out businesses from QinetiQ, at a time when there was pressure on the company to privatise and exploit as many intellectual property rights as possible. It was set up through a partnership arrangement between QinetiQ, Malvern Hills District Council, Worcester County Council and the West Midlands Development Agency, attracting a European funding grant of £591,693 which covered some 26% of the project cost. The development was undertaken by Trebor Developments, known for their Science Park schemes. Phase 1, the Innovation Centre, was built in 1999. It consisted of twenty-three units, ranging between 355 and 2000 sq. ft net internal area (NIA). Phase 2, the 2000 sq. ft Regional Technology Exchange, aimed specifically at providing small business space, was not completed until 2001. This space was accompanied by some grant funding. Four cybersecurity companies moved in between 2002 and 2006. The workspaces were quickly filled. Building out the Science Park needed to continue, albeit that these later stages were aimed at larger companies. Phase 3, built in 2008, comprised larger office space, laboratories, a conference centre and a café. In 2016 Phase 4 was added, a 35000 sq. ft bespoke space for UTC Aerospace Systems. Phase 5 and 6 are currently being planned. The Park director explained that the Park provides more than 300 high-end jobs, in some 35–40 companies, of which at least six are related to the cybersecurity sector. Tenants must be research-based as the planning permission restricts the uses to B1 a and b uses, (office and research and development). The intention has always been, in the words of a board member, “to create a like-minded science-based community”. One commercial agent felt that if the Science Park had not been available these companies might well have moved away from the area. He added that, “The firms like the location next to QinetiQ and the shared resources.” The Science Park was built in a campus style, and the design was mindful of the high security requirements of its target community. It is one of a very few developments in the area providing this type of space and, as described in Section 4.2.4, tenants consider that locating in the Science Park gives a cybersecurity firm credibility.

In 2002, there was space available for the new fledgling cybersecurity companies, however it was full by 2006. The general economy went into recession in 2008, and QinetiQ went through

[28] DERA, the Defence Evaluation and Research Agency – the Government defence organisation that was based in Great Malvern. In 2001 it was spilt into two, and the Defence Science and Technology Laboratory remained part of the Government establishment and moved to Farnborough. The remaining three quarters of staff and most of the facilities stayed in Great Malvern, were privatised and renamed QinetiQ. In 2019, QinetiQ in Malvern employs some 750 people, albeit there remains a programme of downsizing in force.

another downsizing exercise in 2010, with concurrent cybersecurity start-ups emerging on a regular basis from 2009 onwards. Some of the companies were founded at home in "kitchens", as described by one interviewee. By 2012 many start-ups companies were looking for "move on" space, yet there was almost none available. The property market recession caught up with Malvern in 2010, and nothing was being built. Figure 6.9 below shows the trends in vacancy rates at this time. They have gradually been falling since 2016.

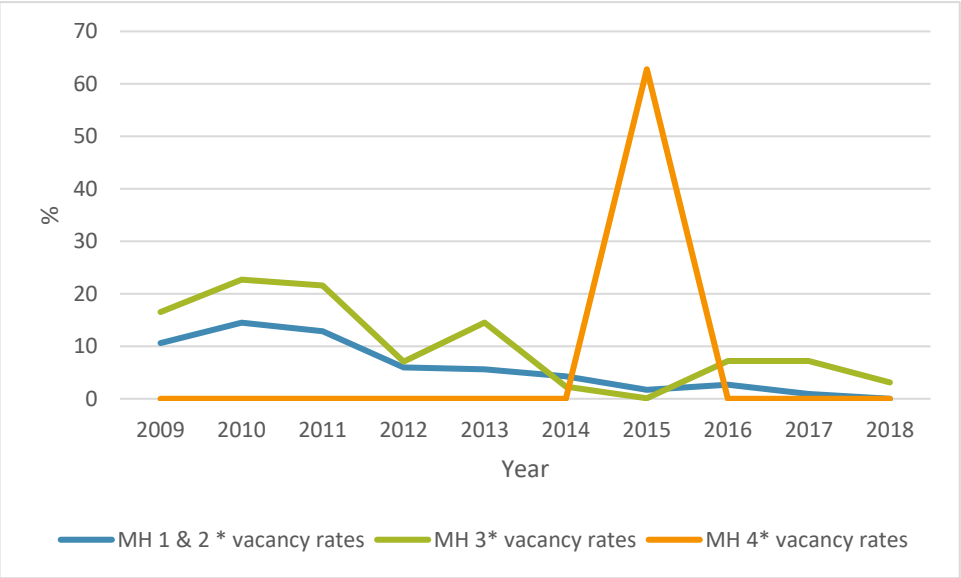


Figure 6.9 Malvern Hills District, comparison of annual office vacancy rates by type.

Source: Costar 12/2/2019[29]

All grades of property were in short supply,[30] but were especially limited in the "move into" category, i.e., 1* and 2* space, which dropped from 12% of the total in 2010 to almost zero in 2015. This predicament led two cybersecurity entrepreneurs, Emma Philpott and Adrian Burdon, to buy a building just north of the town and start the Wyche Innovation Centre in 2012, as described in Sections 42.4 and 5.2.4. The Centre not only provided space for their own companies but had spare capacity for several more. It quickly became the home of some five or so small cybersecurity companies, plus it provided hot desking facilities for more. The hub, became emblematic of the local cybersecurity industry and helped to cement the area's status as a cybersecurity cluster.

[29] The spike in 4* space in 2015 is related to the completion of the pre-let space to UTC Aerospace Ltd of Phase 4 of the Malvern Hills Science Park.

[30] Costar workspace data is graded:

1* & 2*: Small and in need of refurbishment
3*: Older, some refurbishment
4*: New or refurbished, efficient

Source: https://www.costar.co.uk/docs/librariesprovider5/knowledge-centre-documnets/ratingsytem.pdf

Since 2015, many of the young companies have successfully grown and matured. The lack of appropriate workspace, however, remains an issue, and is probably responsible for the town's relatively high office rental values in comparison with other regional centres. There was another round of redundancies from QinetiQ in 2018, which fuelled more start-ups. It also put more pressure on the Wyche Innovation Centre, which has filled up quickly. For those businesses that had incubated there, there was almost no "move on" space for growing SMEs, forcing them into high rental situations. One cybersecurity business described how painful the jump from the Wyche Innovation Centre to the Science Park had been in terms of the associated increase in costs: "There were six of us there to start with. Rent was less than 0.5% turnover. It is now probably 0.75% for our space in the Malvern Hills Science Park, about £2000 per month with services on top. Our advisors pushed us to move." The extra expense meant they had a terrible first year in the Park: "It was an *annus horribilis*". Both the quantity and quality of workspace in Malvern seems to be constrained, such that there was no flexibility in times of company growth. Office supply in Malvern is now at a premium. Figure 6.10 shows the overall stock, with almost no growth since 2009.

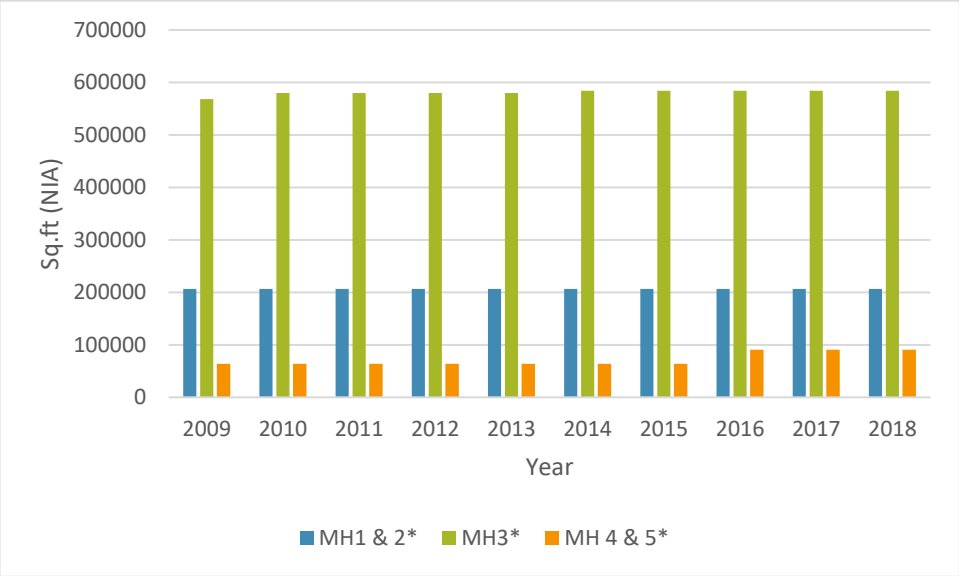


Figure 6.10 Comparison of total office stock by grade for Malvern Hills District Council area

Source: Costar 12/2/2019

Malvern has had a relatively plentiful supply of 3* offices over the years, generally refurbished older buildings in the town centre; but in contrast to the Guildford games companies, cybersecurity companies prefer the modern spacious buildings available in the Science Park, which are more likely to be of 4* and 5* premises (Section 4.2.4). Since 2009, the only new completed office stock was Phase 4 of the Malvern Hills Science Park, undertaken by the public sector. The private sector has simply not been interested in the development of offices, despite the paradox of high tenant demand and relatively high rental levels, which is a curiosity, but

explained by the overall negative rental growth during the period since 2010, which did not encourage investment or development (see Figure 6.11).

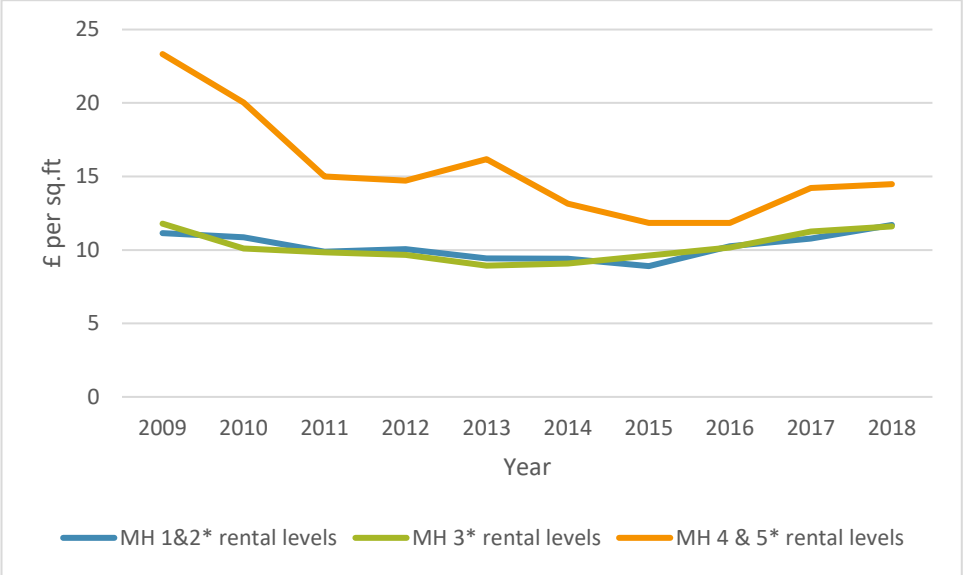
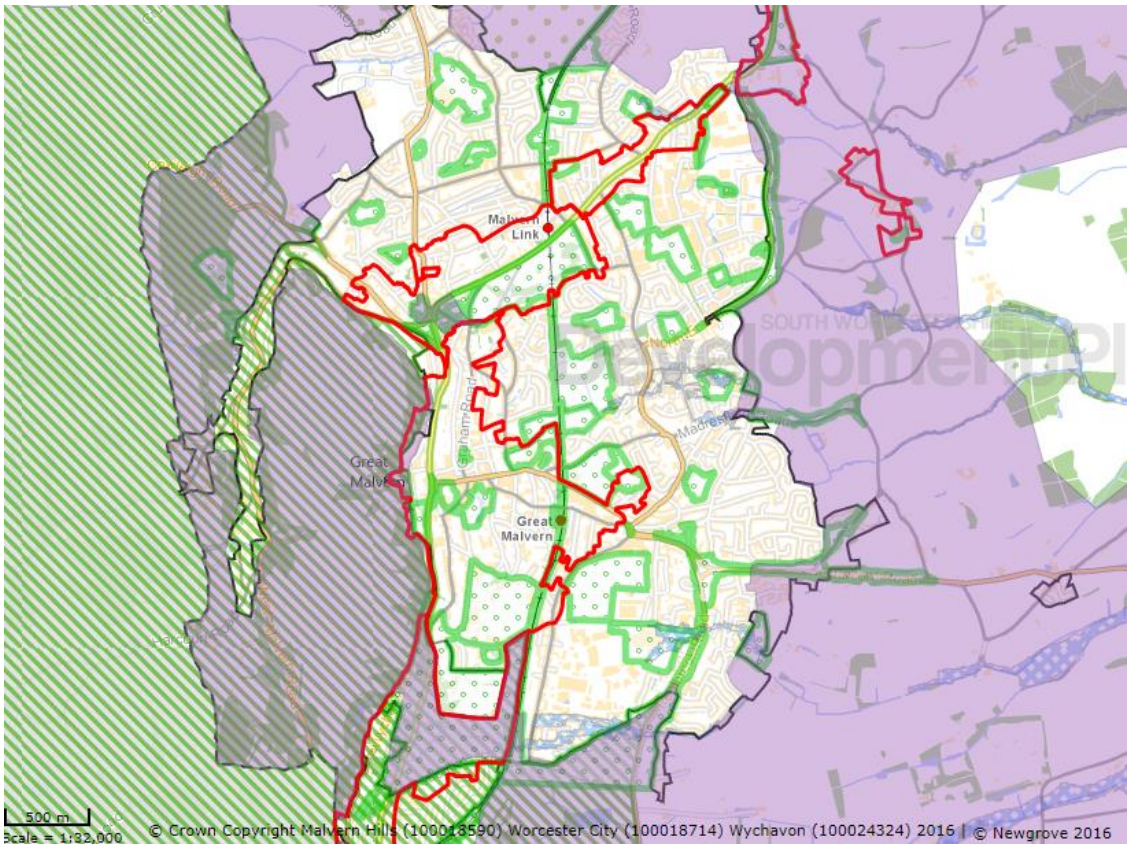


Figure 6.11 Malvern Hills annual rental levels by office quality

Source: Costar 12/2/2019

The situation has not been helped by a lack of forward planning for employment space by the local planning authority. Planning policies for Malvern have constrained development in all directions around the town, through protective landscape policies and a tightly drawn urban development boundary (Figure 6.12). To the west, growth is constrained by particularly strong landscape polices, the Malvern Hills AONB,[31] and to the north by a "significant gap" landscape protection policy.

[31] Area of Outstanding Natural Beauty.



	AONB
	Significant gap
	Green space
	Development boundary
	Protect and enhance landscape policy area
	Functional floodplain
	Conservation area boundaries

Figure 6.12 Extract from the South Worcester Development Plan, 2016

Source: http://swdp.addresscafe.com/app/exploreit/default.aspx

It appears that employment site identification has not kept up with local industry needs, favouring housing development instead, as evidenced in the Local Plan Employment Land Monitoring reports, leading to "the distortion of the property market in favour of residential development [which] is a significant problem of the maintenance and growth of employment opportunities within South Worcestershire" (Roger Tym and Partners, 2011). A subsequent report encouraged planning policy to support the provision and preservation of cheap flexible space for the town's

"large entrepreneurial community" (Roger Tym and Partners, 2017: 21). These recommendations have, to a large extent, been taken on board in the emerging combined South Worcester Development Plan, where there is a discernible change in tone regarding commercial property development. The plan includes a special policy to safeguard and develop research-based activities in the Malvern Science Park.[32] This new planning policy direction may be what is needed to push-start the property market, and may be partially responsible for the signs of a slightly better market performance. Figure 6.11 shows that rental levels are starting to rise very slightly.

The example shows how it is not just planning policies but their implementation and associated institutions that can impact property markets, a major field of inquiry by Healey and her contemporaries in the 1980s (for example Barrett et al., 1978a; Barrett and Healey, 1985).

The chart shows how over the past two years, Malvern Hills, with an average rent of £12 per sq. ft, saw rental growth of 10%, which is the highest in the West Midlands region (RICS and CoStar Office Market Report Herefordshire and Worcester Market 12/2/2019). Rental growth for 1* and 2* properties has caught up with that of 3* properties, perhaps reflecting the increased greater demand from "break-out" digital entrepreneurs, and demonstrating differential sub-markets' dynamics. Of course, this is not good news for young research companies, but with the prospect of rental growth, developers may be encouraged to provide workspaces – if they are aware of the opportunities.

As demonstrated in Figure 6.11, Malvern rental growth is always behind that of the other case-study property markets. This gives weight to a possible secondary explanation for the lack of private sector development, that of a property market "information gap". The interview evidence suggested that the town was perceived as isolated – that, as one local agent said of Malvern, it "is a bizarre place, out on a limb". There was little understanding of the locked-up potential of burgeoning cybersecurity firms. Interviewees complained about local agents: one CEO who moved into the Science Park in 2010, after the property market crash, felt aggrieved about his treatment by local agents and suggested that the cyber firms were not "in the club of land". On the basis of the survey evidence, it appears likely that the Malvern commercial property market is largely locally generated from spin-outs and the growth of existing firms, rather than firms relocating into the town. It is postulated that outside firms may not seek to relocate to Malvern because of either negative perceptions of the built environment, workspace availability and transportation connections, or because they are simply unaware of the prospects, due to an information gap, a lack of both internally and externally circulating property market information.

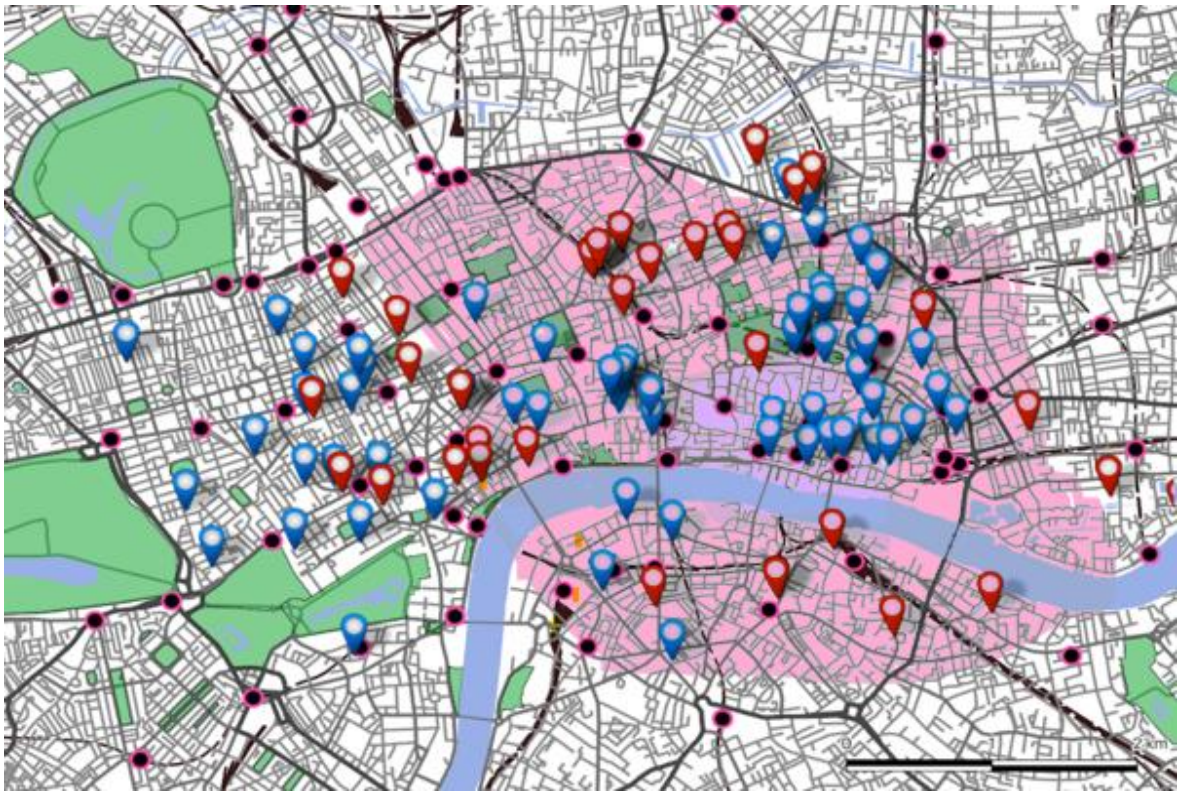
[32] Policy SWDP53 of the South Worcester Local Plan, 2016

Section 5.2.4 showed how levels of interactivity between businesses in the sector are weak, added to which, there are almost no commercial agents based in Malvern. Interviewed agents in nearby Worcester seemed surprisingly unfamiliar with Malvern, probably because there had been little or no activity over the past few years, and the Science Park has dealt with its own lettings. These observations suggest that property market information may well be a key to unlocking dull property markets. The idea has been discussed in the property market institutional literature (for example Evans, 2004; Arvanitidis, 2015), but overlooked more recently within cluster theory. Furthermore, the observations also fit into the idea of provincial property markets being overlooked by what many researchers have described as the traditionally London-centric, regionally biased, risk-adverse investment market (Hamelink et al., 2000; Guy et al., 2002), but they also suggest that the dearth of information is to an extent caused by a lack of local information flows. This exchange of information is worthy of further investigation if provincial economies are to be considered seriously as hubs for digital-age business.

In summary, Malvern demonstrates a dull property market. The growth of the cybersecurity cluster has to a large extent been afforded through a public/private partnership to create the Malvern Hill Science Park and the industry-driven Wyche Innovation Centre start-up space. Together they have provided a supply chain of workspace which has suited the expansion of the firms. The study demonstrates how, as was also the case in Guildford, timing has been central to the continued growth of the cluster, since start-up workspace availability was synchronised with layoffs from QinetiQ. The 2018 round of layoffs was more difficult to accommodate, as space had become more constrained. The study shows how gaps in property market information and a lack of political will in the planning authority may contribute to a lacklustre property development market. The findings add new insights to ideas about provincial property markets, and the role of information flows and planning policy, in sustainable cluster development.

6.2.3 The London games and cybersecurity clusters

Sections 4.2.2 and 4.2.3 showed how the clusters of digital games and cybersecurity are to a large extent co-located in EC1 and EC2, the Clerkenwell and Shoreditch areas, on the fringes of the City of London, as shown in Figure 6.13.



	Games company
	Cybersecurity company
	Railway station (under and over ground)
	"City fringe" property market sub-area
	"City" property market sub area

Figure 6.13 Location of digital games and cybersecurity firms within property market sub-areas[33] in central London

Clerkenwell and Shoreditch are included within the industry-recognised "City Fringe" property market sub-area. Quoting property agent Chris Whitfield of Keatons Lettings Agents in 2015, the area

> *is recognised as a location for major office uses, creative, cultural and tourism activity, and major public sector uses such as the London Metropolitan University and the Royal London Hospital… growing in popularity since the mid-90s with momentum*

[33] Property market sub areas as depicted by Savills UK City Office: market watch January 2018. https://www.google.com/search?q=savills+uk+city+office+market&sxsrf=ALeKk004N24_NXBBNscG2ZHc3DEBIXcleA:1614263175508&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjQs5n5noXvAhVEolwKHXNUC2wQ_AUoAnoECAYQBA&biw=1920&bih=969#imgrc=le_zdQVsTgos_M

increasing with the success of the Olympics bid in Stratford, improved transport links….. A key element of the change to the area has been the regeneration of Old Street. The government coined the name "Tech City" for the area in 2010 and offered tax breaks for start-up IT businesses. Since that time, Tech City has become globally renowned and viewed as a major driver for London being at the heart of the European technology sector. (Based on https://www.onthemarket.com/content/city-fringe-why-is-it-important-property-market/)

The Tech City initiative, one of several regeneration policy initiatives for the area, was kicked off by the City Fringe City Growth Strategy, a public-private partnership initiative working together with the London Boroughs of Camden, Hackney, Islington and Tower Hamlets.

The City Fringe area is an expansion area for the City of London. When the financial economy is doing well, businesses "spill" into the City Fringe property submarket area. This means that the commercial property market is particularly prone to expansion and contraction depending in the health of the City, which creates supply issues for the digital companies that associate specifically with the Fringe area. Figure 6.14 shows how average rental values for the City Fringe sub-market over the past twelve years are part of a property market cycle which can be directly related to the financial cycle. Rents were at their lowest in the recession of 2008, and built gradually to peak in 2016, since which there has been a slight decline.

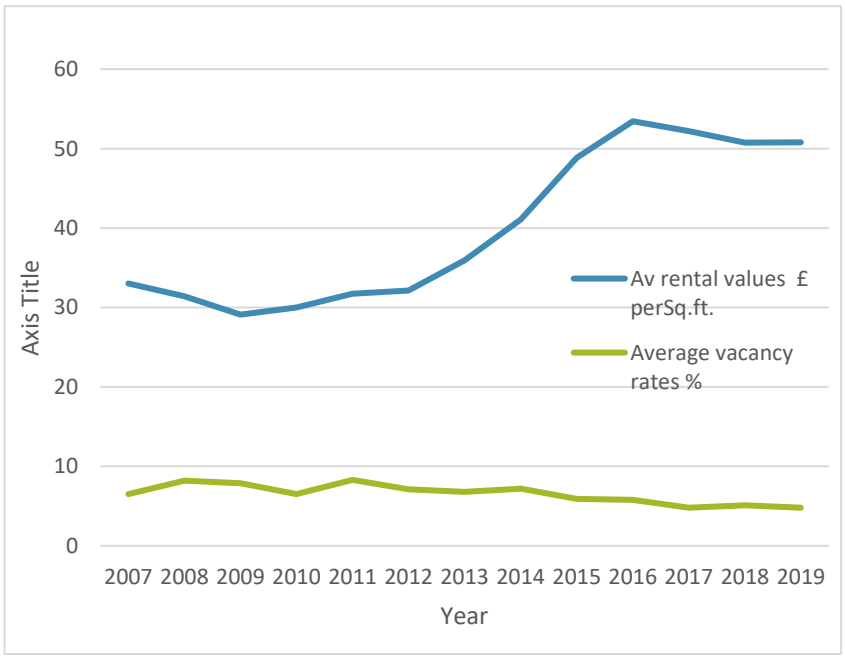


Figure 6.14 City Fringe property sub market areas comparison of annual rental levels and vacancy rates

Source: Costar 12/2/209

On top of this picture are local variations which appear to have had locational implications for the burgeoning digital games and cybersecurity clusters. The following subsections piece together a historical narrative for both niche sectors related to the fortunes of the local commercial property markets.

Digital games companies in Clerkenwell

The games industry emerged in London in the 1990s when mobile phone technologies took off. Initially, founders tended to be based at home, and there was evidence that many continued to stay on at home longer than those outside London did. One fledgling entrepreneur in the survey successfully converted their garden shed into a workspace, and stayed there, because at the beginning, "nothing else was really affordable" for them. When these fledgling companies start to "move on" into workshop accommodation, Clerkenwell seems to be the preferred choice, being more associated with the arts and marginally cheaper than its popular technology associated neighbour, Shoreditch (as described in Section 4.2.2). In the words of one marketing director, when they moved into Clerkenwell in 1997, it "was close enough to Hoxton Square, without being too cool, it was central, it was cheap. Shoreditch was getting expensive at that time. Clerkenwell was much cheaper." Since that time Clerkenwell has attracted more games companies than other areas of London (forty-five of them) as shown in Figure 6.15.

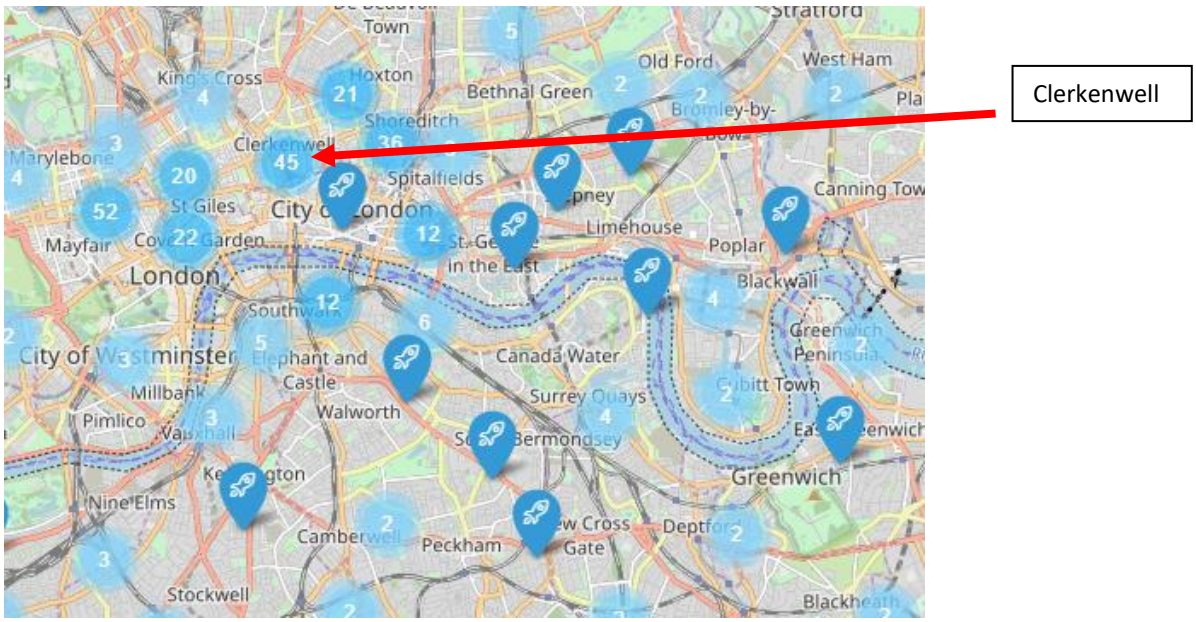


Figure 6.15 Number of games companies in London

Source: Extract from Nesta/UKIE Games Map, 2018

Clerkenwell became increasingly associated with media-related businesses and, as described by one commercial agent, lured the tech market with its "warehouse-style buildings which enable the original character to be exposed" (also described in Section 4.2.4).

The area became increasingly popular with small creative businesses over time. Rental levels fell to low levels for 1* and 2* workshop space in 2009, just after the recession and the property crash, as shown in Figure 6.16. More start-ups were attracted to move into these cheaper workspaces, contributing to already low vacancy rates (Figure 6.17) and there were corresponding rising rental levels from 2012, until they peaked in 2016.

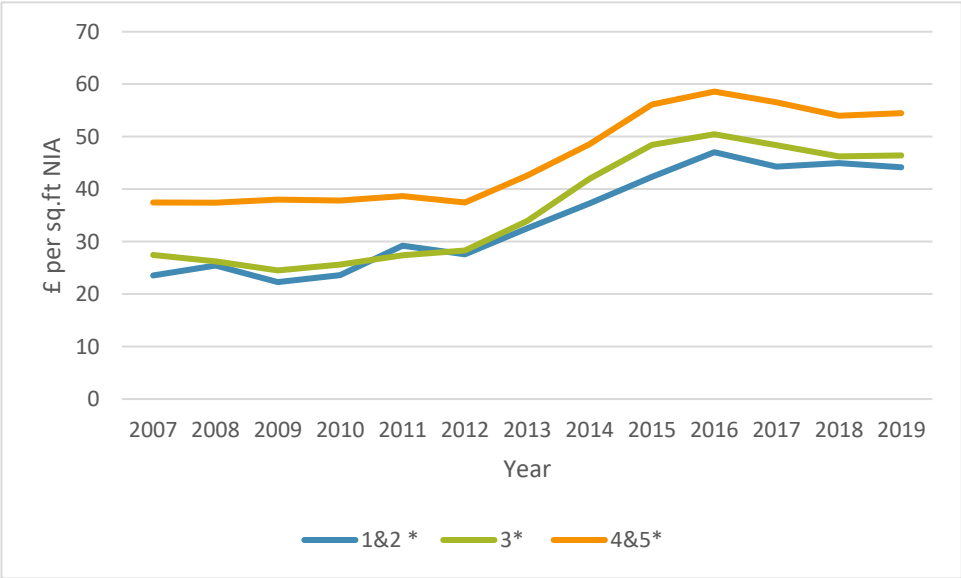


Figure 6.16 Clerkenwell annual rental levels by office grade

Source: Costar 12/2/2019

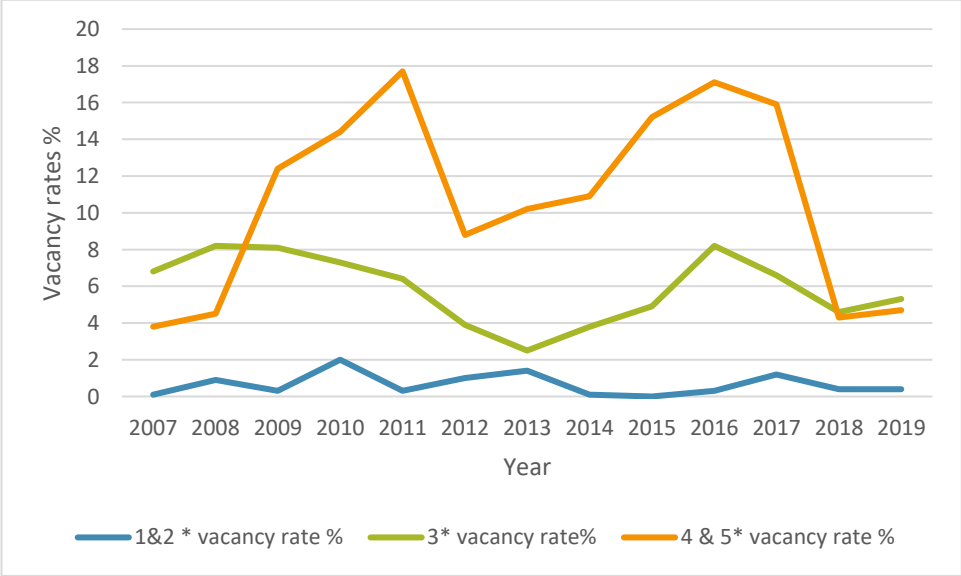


Figure 6.17 Clerkenwell annual vacancy rates by office grade

Source: Costar 12/2/2019

However, the rise in rental values meant that, as leases came to an end, landlords and developers moved in to refurbish the office spaces and further increase rental levels. This effect hit expanding games companies hard, and some found that they were squeezed out of Clerkenwell. A CEO of an

affected growing company described the difficult situation his company found itself in, due to the special circumstances relating to the property market and the business life-cycle evolutionary stage of the London games firms:

> *So, our £15 per sq. ft, Clerkenwell space, they were going to kick us out, renovate it, and wanted to charge us £45 to come back. So, five years ago, there was a massive bun fight for space, basically, all the big firms had started growing again… but all the [games] developers [who were largely small firms] had put the brakes on. So come the summer of 2014, five years ago, everybody's looking for space. And none of the big new developments are finished. So, all the big companies that were looking for new spaces that would normally go and rent a brand new office that has just been fitted out, they were taking all the existing stuff or growing into an extra space. It was a "bun fight". It was like the Wild West. It was 2014.*

The constraints of the property market were compounded by the introduction of permitted development rights allowing for the conversion of office to residential land uses without the need for planning permission 2015. To its credit, the Mayor's Office recognised the problem and encouraged local planning authorities within the pro-employment Central Activities Zone of the capital to implement Article 4 directions withdrawing these permitted development rights. However, it took until 2018 for the London Borough of Islington to do this for Clerkenwell, undoubtedly contributing to the net loss of office stock (see Figure 6.18) and rising rental levels between 2015 and 2018 (Figure 6.16). It may be that the intervention helped stem the tide of further office stock losses from 2019.

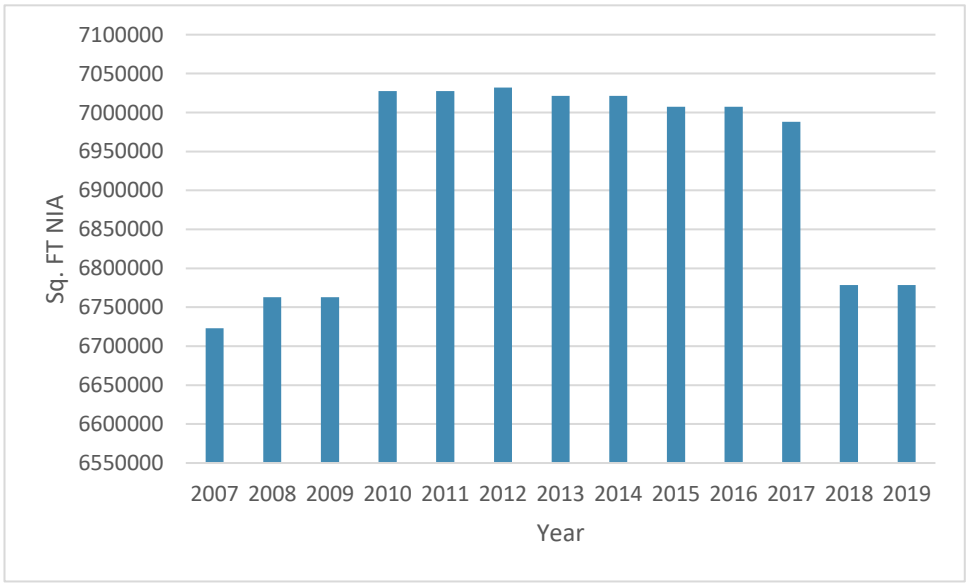


Figure 6.18 Clerkenwell total office stock

Source: Costar 12/2/2019

This loss of ordinary office stock corresponding to an increase in residential and quality office uses typifies regeneration cycles (Hutton, 2008), and is evidenced by the enormous rise in freehold sales at the expense of lower quality office space (see Figure 6.19).

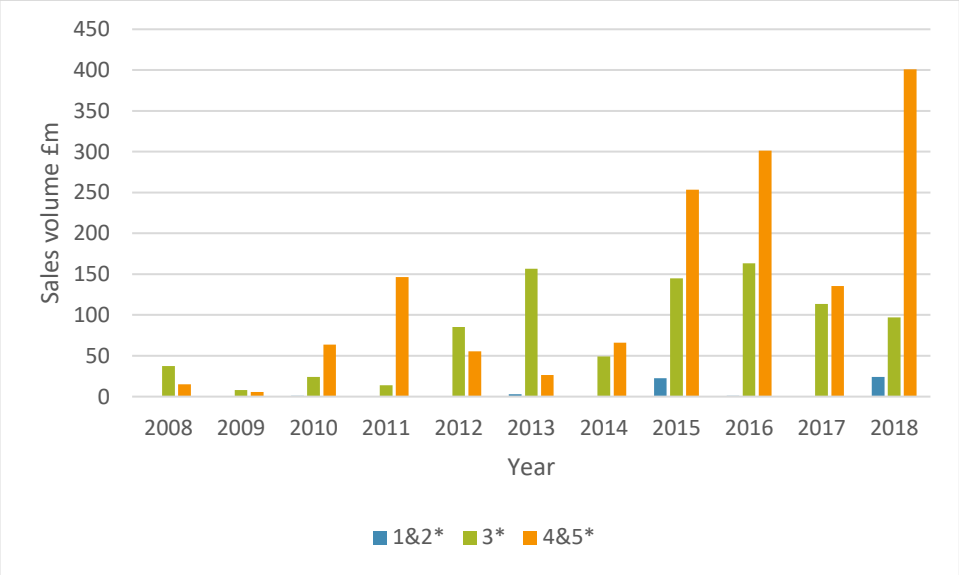


Figure 6.19 Clerkenwell sales of freehold office space by office grade

Source: Costar 12/02/2019

Clerkenwell's semi-industrial buildings were ideal for conversion (for example Figure 6.20) into residential, flexible working spaces and large, quality office spaces once major companies such as Google, LinkedIn and WeWork moved into the area.

Figure 6.20 Refurbished ex-industrial building in Clerkenwell

Source: author

As described by the commercial agent in the introduction, and other researchers, the area became an excellent example of regeneration (for example Florida, 2002; Bagwell, 2008; Hutton, 2008), albeit debatably another example of gentrification rather than keeping to the original intention of inner city regeneration (Bagwell, 2008; Florida, 2017).

Rents have cooled a little since 2016, which means that small games companies are in with a chance once again in Clerkenwell – albeit that rental levels remain higher than at any time prior to the recent 2014–2016 boom and the availability of spaces remains tight. As one growing company CEO said, “Clerkenwell is expensive but it’s just about affordable for us.”

The role of information flows in finding property is less clear for Clerkenwell games firms. In Section 5.2.2, face-to-face interactivity between games firms was described as weak, but possibly increasing. There was evidence of small games companies engaging in sharing and sub-letting initiatives, but not to the extent that was apparent in Guildford. This may be a trait which will increase, which could in turn start a property-led trail of games firms workspaces, as observed in Guildford, leading to a more sustainable localisation of firms (Malmberg and Maskell, 2007). However, the signs are not positive. It seems inevitable that rents will continue to rise as Cross Rail is due to open and larger tech companies are attracted to the area. Existing games companies will mature and expand, and, facilitated by the good transport connections, may find they are even more dispersed around the capital. Interviewees commented on the immaturity of the industry in London, which as yet has not been through a “boom and bust” cycle, which would produce an ecosystem of start-ups as in the case of Guildford and Malvern. But maybe it is only a matter of time and opportunity.

Clerkenwell is an example of a cluster in the making. It provides a good example of how the interaction of the property market cycle has had a direct effect on cluster development. As with the previous case studies, it demonstrates how firm expansion has been enabled by the fortunes of the property market and the crash of 2008, enabling the emergence of the cluster through the availability of space in the preferred ex-printing workspaces of Clerkenwell − albeit that an appropriate succession of workspaces still needs to be established in the manner described by Foord (2012) and Segal Quince Wicksteed (1985). The ebbs and flows of this very dynamic property market are translating into a fluid cluster phenomenon. The evidence suggests that London clusters may therefore be particularly unstable, and susceptible to the issues of gentrification (Florida, 2017), helping to highlight the complexity of the forces at work in metropolitan areas.

The weak levels of face-to-face interactivity of the niche sector, and inferred low property market information flows may also be having an impact on consolidation. A more in-depth study of

differences in property market information flows in terms of sustainable cluster development would be worthwhile.

Cybersecurity businesses in Shoreditch

As described in Section 4.2.3, the development of a cluster of cybersecurity firms in London appears to have coincided with the growth of flexible working space in the City, which suited their workplace preferences and business models. Flexible workspace is a generic term for a raft of workspace types described by the Royal Institution of Chartered Surveyors as "real estate space of varying size provided for business or institutional purposes for varying periods of time, usually for shorter periods and with more inclusive benefits than a traditional lease" (RICS, 2019:5). Since the first co-working hub of London was started in the Angel, Islington, in 2005, many forms of shared space have developed. The Cushman and Wakefield Report 2018 describes how flexible working spaces are an evolving concept of shared space, ranging from serviced offices, which offer desks and offices at fixed prices; and co-working spaces; to a growing spectrum of differing levels of access to facilities, legal and management arrangements, and fee rates. For example, the Trampery, a co-working space in Bevenden Street, Shoreditch, opened in 2009 and is run as a social enterprise, with its corporate structure limited by guarantee. Income for the centre comes from desk licence fees and events (Payne, 2013).

Figure 6.21 The Trampery co-working space

Source: author

It is generally acknowledged that the amount of flexible workplace stock in London has seen a sizable increase, albeit accurate data is hard to come by. A paper by Eltringham (2019) describes an increase of 69% between 2014 and 2019. Figure 6.22, extracted from the Cushman and

Wakefield 2020 report, indicates that the stock of flexible workplace in London between 2007 and 2017 increased by more than three times.

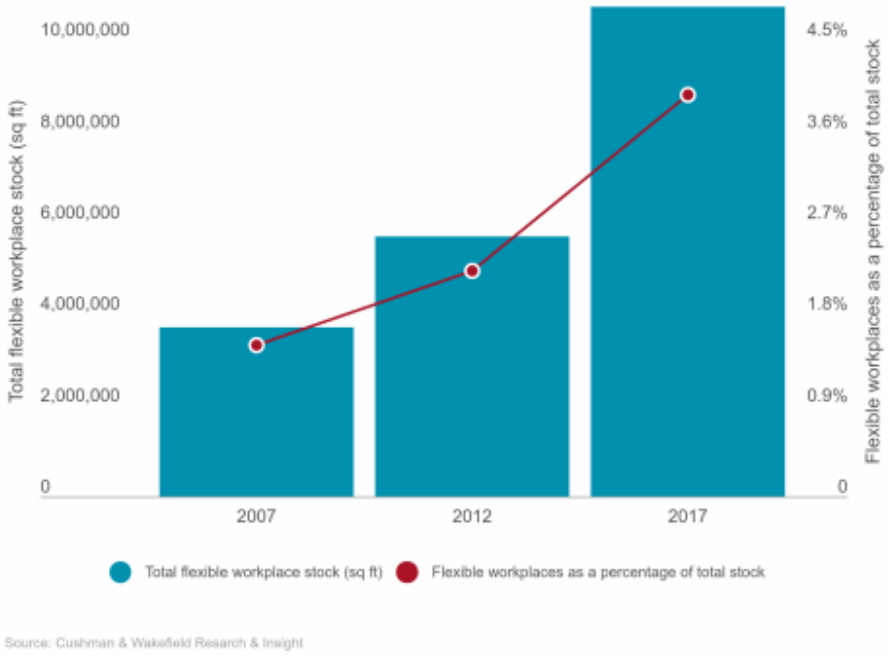


Figure 6.22 Flexible workplace stock

Source: Cushman and Wakefield (2020)

What is clear is that this spectacular rise probably started as a response to the property market crash in 2008, which saw offices being sub-divided and let on more flexible terms. This suited the volatility of the emerging tech market (Merkel, 2015) including, presumably, the cybersecurity niche sector. However, the rise has peaked (on the basis of pre-Covid data). The Cushman and Wakefield 2019 report demonstrated an oversupply of these workspaces, with overall occupier demand starting to fall, as shown in Figure 6.23:

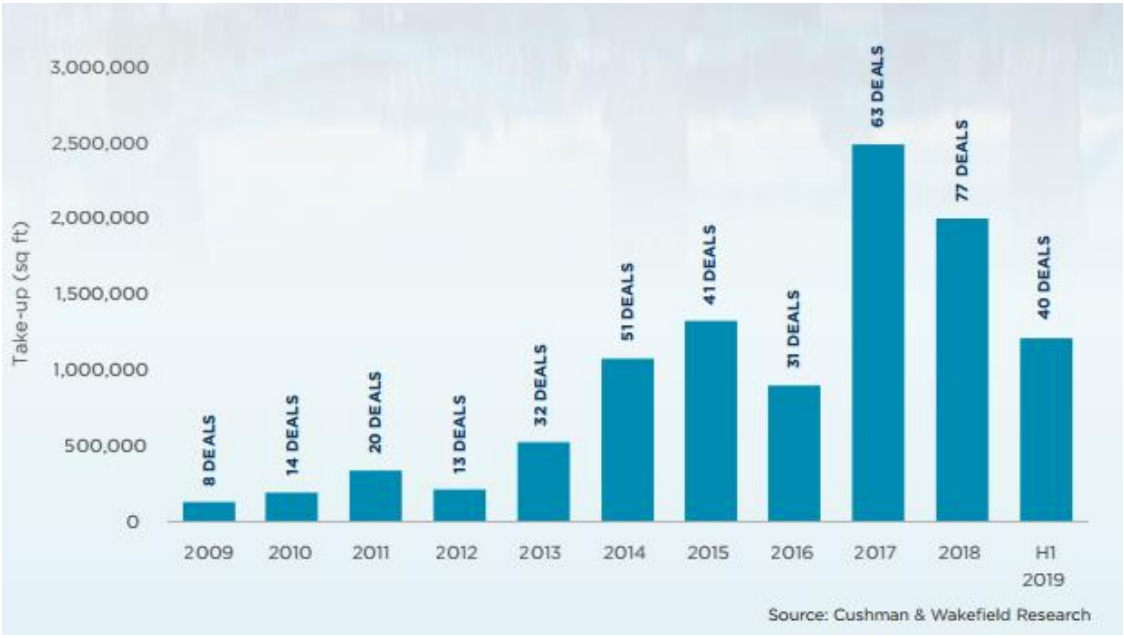


Figure 6.23 Occupier take-up of flexible workspace 2009–2019

Source: Cushman and Wakefield (2019)

The fall in demand may in part be due to increasing frustrations with the nature of the workspace, a point picked up on in this survey. The first raft of occupying firms now expanding and consolidating their operations require more centralised desk-based activities. A US-based multinational vendor described clearly how such spaces seem to work for those organisations who on the whole are managing remote workers; but for those who need to spend more time in the office, sharing space has its disadvantages in terms of noise levels and privacy: "You get guys who are rather loud on the phone, like me and other Americans. And you get guys who want to be quiet when they're on the phone. Sometimes it works, sometimes it doesn't."

Not only are niche sector requirements changing due to the oversupply situation, but we are also seeing responses within the flexible workspace property market. Property market reports (for example Cushman and Wakefield, 2019 and Instant Group, 2018) highlight how the diversity of the property on offer is increasing, as landlords compete for a decreasing market. Branding is a common tool and, as was noticed in Guildford (Section 4.2.4), specialist developers have emerged that recognise the demand for bespoke niche-sector workspaces. Digital Shadows, a major cybersecurity firm, recently bought and partially occupied the Columbus Building in Canary Wharf, and is now letting the remainder of the building as co-working space, attracting a high proportion of fellow cybersecurity firms. Such small hubs have the potential to be the seed for a larger sustainable cybersecurity cluster.[34]

[34] https://www.digitalshadows.com/blog-and-research/digital-shadows-opens-new-state-of-the-art-london-office-in-canary-wharf/

This case study demonstrates an intimate relationship between the evolution of the sector and the evolution of a very specific property market sub-sector. The property market crash of 2008 was responsible for the blossoming of the flexible workspace property market sub-sector, which facilitated the arrival of (often remote-working) cybersecurity companies. The maturing of the firms has led to changing working practice spatial needs, more space and more privacy, which when combined with an oversupply of tradition flexible workspaces appears to be driving change in the property sub-market, contributing to a diversification trend. The effect is such that the niche sector may be becoming more spatially identifiable, which could add to its conspicuousness as a cluster. The evidence adds a dynamic perspective, and in particular the need to recognise the role of the property market in the literature on place making and cluster branding initiatives (Nathan et al., 2019).

6.3 Reflections on the outputs

The aim of this chapter has been to probe the dynamic elements of the digital clusters, the effects of the local property markets on business and cluster dynamics over time and the reasons for any differential responses.

6.3.1 The effects of the local property markets on the changing needs of the businesses.

The case studies show how, to date, the clusters have evolved through the availability of appropriate workspace at the right time and place in the growth cycle of the digital businesses. This observation must have the caveat that the study did not extend to firms leaving the cluster, albeit that there was little evidence of this. This process of cluster evolution has not always been plain sailing. In Guildford, the cluster has benefitted from an unusually large supply of appropriate, small, interesting workspaces with flexible leases, assisted by protectionist planning policies in the town centre. Available cheap, semi-industrial space in Walnut Tree Close, within walking distance of the station, was especially taken advantage of between 2015/16, a time when there was a surge in the number of start-up and “move-on” companies following the closure of the Microsoft studios. In Malvern, start-ups were enabled to emerge from home working when new workspace in the Malvern Hills Science Park became available contemporaneously with the downsizing of QinetiQ in 2001, and again in 2011, when more downsizing occurred and the Wyche Innovation Centre which had just opened its doors. The 2018 round of layoffs has been more difficult to accommodate, and firms are now “crammed” into the Science Park. The London mobile games firms followed a similar pattern of niche sector development, with entrepreneurs taking advantage of the growth in consumer interest in mobile phone games, initially working from home, and only emerging and taking space in their favoured Clerkenwell area from 2009

following the property market crash of 2008. Cybersecurity companies preferred the flexible working spaces which proliferated especially in neighbouring Shoreditch, again after the 2008 property market crash. Seemingly, they emerged contemporaneously, which suggests that the availability of this form of space facilitated their arrival and the growth of a cluster.
Change and adaptation have been apparent in each case, both through adaptive measures of the digital firms and within the property market. Maturing companies often start to exhibit preferences for more privacy and individualised workspace as they seek to expand. The London games firms were unable to find the requisite expansion space on which to stamp their individuality in Clerkenwell – there was little available at the right price in 2014, when rents in Clerkenwell peaked – and they had to relocate to more peripheral yet still centrally connected London locations such as London Bridge, the Oval and Finsbury Park. Guildford firms have had an easier ride since they have little competition for the small-town centre spaces, which they prefer, since they don't have to compete with other sectors for the protected space. As described in Section 4.2.1, this monopolistic property demand scenario has meant that landlords have had to submit to their demands and are, unusually, offering very short flexible leases which suit this particularly volatile industry. Equally, the specialist demand potential of the games cluster has been recognised by developers through the development of bespoke town centre space. Expanding Malvern cybersecurity firms are in a more difficult position, with little or no appropriate workspaces being available and a lack of interest from developers in supplying it.

Unlike in the metropolitan case studies, where relocation is an option when rents get too expensive, the provincial firms are faced with a starker choice. Relocation would mean losing out on both the cachet derived from locating in the town and, in the case of Guildford, the information flows afforded by the tightly co-located community (Section 5.2.1). These observations accord with Duranton and Puga's (2003) observation that London-based technology firms are less embedded than their non-London counterparts, an idea which is developed in Chapter 7.

6.3.2 The reasons for differential responses of the property markets to business demand.

The response rates of the local workspace markets to occupier demand were shown to vary by case study. Figures 6.1 and 6.2 demonstrate how London property values are on average more volatile and responsive to the financial cycles, whereas the impact of the property market crash of 2008 lasted much longer in Malvern. Average rentals peaked thereafter at correspondingly later times with distance from the capital, London in 2014, Guildford 2015, and Malvern 2017. An advantage of both Guildford and Malvern from a rental point of view, is that the property market cycles are less violent, with the curves being relatively smooth, and rental levels changing at a

slower pace. These cycles can work with cluster development (Guildford) or against it (Malvern) depending on the stage of cluster development and its relative market strength. It is proposed that the local property markets are much more nuanced than these simplistic property market cycles suggest, with different property market efficiency rates, in which the clusters play an intimate and synergistic role. For example, the Guildford town centre office market is monopolised by the games firms with landlords bending to their demands. The growing ecosystem of firms since 2014 has helped the town centre sustain rental values which in turn will have given developers confidence to undertake speculative building with the games firms in mind. In contrast, the dull or failing property market in Malvern has not responded to the clear demand among the cybersecurity firms for new space. There are plans to expand the Science Park, but these will take place as and when the public sector partnership is enabled through government funding rather than through market conditions. In London, the clusters are diluted by a more mixed economy, albeit that the digital sector continues to dominate and there is evidence from both this study and recent property market reports, that they are driving change in the nature of new workspaces, with branding becoming the marketing tool for workspace differentiation (Cushman and Wakefield, 2019; Instant Group, 2018). There was also evidence of the competitive effects of property sub-markets and the rise and popularity of flexible workspaces starting to change attitudes amongst traditional Clerkenwell landlords such they are prepared to be more flexible when it comes to leases, space and fit-outs. This “fight back” trend may also be partially responsible for the decreasing popularity of standard flexible workspaces, but then, as described, the flexible workspace market has responded by becoming more differentiated. The metropolitan situation is highly complex and integrated, but the property market is finely tuned and responsive, certainly to the demands of digital firms as recognised in London property market reports (for example the British Council of Offices, 2014; Cushman and Wakefield, 2019).

An interesting observation was the similarity of the development of cheap start-up space in both Guildford and Malvern, reacting to niche sector demand, by niche sector industry champions, rather than by the private property development sector. Similarly, whilst the Malvern Hills Science Park has largely been funded through the public sector, the idea was championed by the private sector, QinetiQ. The question remains as to why this has happened in the provinces and not in London as yet. It could reflect the maturity of these clusters or the more simplistic property markets such that industry champions, accompanied by their in-depth knowledge and confidence of their respective sector needs, feel able to take the risk and help to provide much needed workspaces when the demand has been overwhelming. The role of champions in cluster development has been identified in previous literature (for example Gibson, 2015), but this observation adds an interesting new idea to the field of research.

The study adds nuance to the idea of differential property market efficiencies (as described in Section 6.1), appearing from the evidence to relate to such variables as built form, planning policies, property values, competing markets, and levels of interactivity and property-related knowledge flow. Each is discussed in the context of the case studies as follows.

Built form and planning policies

Those property markets which exhibit a distinguishable built form tend to be recognised as a sub-market of their own (Hutton, 2008). it is noticeable that Clerkenwell with its preponderance of old semi-industrial buildings is differentiated in the property market press from the City Fringe sub market zone in general (Figures 6.1 and 6.2), and Guildford Town Centre with its historic core is differentiated from the wider town area, whereas Malvern is not subdivided into town centre or out-of-town sites, nor is Shoreditch differentiated from the City Fringe in general. It is proposed that this differentiation inevitably assists property market actors to identify with the areas. Agents, for example, pick up on an industry/built form/niche workspace demand relationship, which sets up a circle of causality whereby built form developments of a certain type, attract certain developers to an area and set in motion a cycle of development, renovation and conversions based on well-tuned property-market knowledge flows. Guy and Coaffee (1999) describe this phenomenon in terms of “islands of development”, “a distinguishable built form in a compact area caused through heightened property market efficiency and profit margins”. The effect of this specific place-based property sub-market is not always clear cut, but the fact that Guildford town centre is recognised as being synonymous with the successful games industry may be one of the reasons why Guildford now has bespoke developer interest in refurbishing town centre space for the games community – whereas, to date, the cybersecurity community in Shoreditch has not been especially recognised (except in this study), nor the property sub-market defined, and bespoke development has not occurred. This observation suggests that the alignment between property market identification and branding with cluster geography could be important in terms of cluster development, and worthy of deeper investigation.

These built-form property sub-markets may also be reinforced by planning policy. The small floor plates of the town centre space in Guildford and the old printing works landscape of Clerkenwell have been protected through conservation planning policies, much in the way as described in the creative economy literature (for example Hutton, 2008; Scott, 2006; Mommas, 2004; Indegaard et al., 2012; He and Gebhart, 2013). However, this study shows that planning policy can also work against cluster development, due to its tendency towards restrictiveness and, more recently, a bias towards housing development (Section 2.4.2). In Malvern, landscape protection policies seem to have had a stronger sway over the hearts and minds of local politicians than the results of the

employment needs report. This resulted in insufficient employment sites being allocated to suit the needs of the burgeoning cybersecurity industry, a finding which gives credence to the work of Cheshire et al. (2012; 2014) and Needham and Louw (2006), both of whom recognised the negative effects of planning policies on the provision of employment space. The lack of prioritisation of employment land support policies reached its heights in 2015, when the changes were made to the Town and Country Planning (England) General Permitted Development Order (Section 2.4.2.2), allowing the easy conversion of business space to residential use. Only by overturning this policy in London, through the Central Activities Zone pro-business policy in the London Plan, has any control on business workspace supply been achieved. Yet even in London, despite centrally supportive employment policies, the London Borough of Islington might be accused of lacking interest in supporting business uses by its tardiness in implementing the required Article 4 direction. Guildford Borough Council, likewise, is still discussing whether to implement such a direction, and meanwhile the games cluster is losing its much-needed low grade workspaces in Walnut Tree Close to housing and student accommodation. The question is raised as to whether the institution of land use planning suffers from institutional lock-in, relative to the needs of business (North, 1990; Gibb et al., 2002; Needham and Louw, 2006). One way or another, planning policy and its processes have an important role to play in how the workspace market in each case study area operates, as also reflected in the work by Osman (2015).

Property values and competing markets

Private-sector property developers and investors can only respond to the market if there are perceivable profits and returns to be made over a period, which include the uncertainties involved in the build time, costs and letting periods. There is a great deal of uncertainty involved, which makes them risk adverse (Harvey, 1985; Healey, 1990; Evans, 2004: 84–87) This is one of the reasons, as described in Section 2.4.2, for the lagged response of new property supply to demand. Larger players especially, who are less agile in their response rates, look for indications of sustainable growth over a prolonged period (Keogh, 1994; Guy and Henneberry, 2000). The literature has described some of the challenges of meeting the volatile demand patterns of some technology industries, with reference to workspace provision for the creative industries in the inner city (Pratt, 2007; Hutton, 2008: 113–114). There is generally a clear relationship between sustained rental growth and net increases in office floorspace. In both Clerkenwell (Figure 6.18) and Guildford town centre (Figure 6.14), there are demonstrable increases in office floorspace between 2007 and 2008, said to be the property development reaction to the post-recessionary up-turn in the economy and the perception of a period of sustained market growth. However, the relationship between demand and supply, as shown, is rarely this straightforward. Response rates are also affected, for example, by competition from other property sub-markets for the same

space. This is especially true in the mixed London economy, but the games cluster of Guildford has fared well through a lack of competition for the town-centre space. The only threat has been competition from the residential property market, with residential conversions of town centre workspace facilitated by the permitted development rights.

Levels of interactivity and the flow of property related information

Central to the ideas in both above sub-sections is the role of reinforcing property information flows, as was introduced in Section 2.4.3 the literature review. The "islands of development" phenomenon (Guy and Henneberry, 2000) neatly overlaps with the idea of the "locale" (Vinodrai, 2006), that is, a place being inclusive of its knowledge resources, central to which may be property-related knowledge. Property-related demand information is likely to flow onwards to local property actors including tenants agents, developers and investors. Where these actors are well aligned and with heightened local interactivity, property markets will work responsively and efficiently (Raco, 1999: 956; Maillat and Lecoq, 1992; Evans, 2004: 61–76), and ultimately (as described by D'Arcy and Keogh (1990: 80)) contribute to its adaptive efficiency.

Chapter 5 focused on the levels of interactivity amongst the businesses in each case study, and it is suggested that these observations can be applied to the circulation of local property market information, such that in the cases of heightened levels of inter–niche sector firm interactivity there may be a direct relationship to a more accommodating property market. Marshall (1890) was fully aware of the effectiveness of industrial districts in communicating property-related information, which he said fed into a circle of causality and increased clustering tendencies. The idea has not been addressed in more recent literature. The highly interactive games cluster in Guildford, augmented by the high number of estate agents, may have played a major part in the clear responsiveness of the town centre property market to its particular needs, such that it could be said to have a heightened "property market purpose efficiency", i.e., "the credible commitment, serviceability" or effectiveness in providing these property outcomes that the urban economy requires", "at the prevailing price" (Arvantidis, 2006: 124). Conversely, a breakdown in information flows, due to weak knowledge flow and few estate agents, has been shown to contribute to the failure of the private-sector property market to respond to the needs of the frustrated cybersecurity cluster in Malvern. The case-study evidence supports Malmberg and Maskell's (2010: 400) observation of the effectiveness of informational flows in reducing the search costs of finding workspace for start-ups companies, whereby same-sector firms start up in a locality because co-location "might imply economising on locational search costs: the prior local existence of one or more successful firms in an industry proves that no obvious or obscure locational factors makes an area less suitable for that specific kind of economic activity". This

study suggests that this is indeed true for young digital businesses, with games firms in Guildford, and increasingly in Clerkenwell, sharing workspace with peer firms. There was no evidence of cybersecurity firms operating in the same way, and this may have to do with niche-sector cultural differences including heightened security requirements, or perhaps their lower levels of inter-business connectivity as described in Chapter 5. It is proposed that the role of property market information flows in cluster development is an area worthy of further in-depth study. Whilst public sector funding of workspace development has been a solution in many areas where market gaps exist it maybe that an examination of the reasons behind the market gaps reveals property market information flow deficiencies which can be relatively simply rectified.

6.4 Conclusions and contributions to the literature

Whilst the study was limited to an exploration of firms within clusters and did not extend to those that had moved away or were not in clusters, there is evidence to support the idea that the digital firms in each case study appear to have been accommodated in niche-sector preferred workspace in a relatively timely manner, which has led to the development of the clusters. However, the property market response rates have been variable and reflect an organic muddling process rather than a planned strategy for growth. In Malvern, a cluster only exists through public-sector support for the building of the Science Park. In the other cases, it has been shown how the ebbs and flows of the local property market have benefitted the digital sectors, with Guildford games seeing a major spin-out incident in 2016 with the closure of the Microsoft studios, when there was plentiful small workspace availability in the town centre. London games and cybersecurity were also emerging sectors at a time which coincided with the property market crash, which meant that small, cheap premises were available.

Maintaining a supply chain of property for the growing companies is difficult, especially in volatile property markets such as London, albeit that London is shown to be a special case with absorptive neighbouring areas for expanding firms for both niche sectors, should expansion necessitate relocation. The London property market is more volatile than the non-London markets, and is subject to a greater complexity of demand factors due to a more diverse business population. In contrast, the more homogenous markets of Guildford and Malvern are easier to recognise, and are more aligned with property-defined submarkets. They should also be easier to plan for, providing there is the political will – an issue in Malvern. The relative simplicity together with heightened interactivity and property market knowledge flows has made the Guildford town centre property market particularly responsive to the needs of the games firms. Malvern is quite the opposite, explained in part by the low levels of interactivity, property information flows, and a lack of forward planning for new workspace by the planning authority. Despite the superficial

simplicity of a homogenous property market, all markets need to cater for the life-cycle stages of the niche sectors and provide a corresponding portfolio of workspace in both time and space. Cluster development is sustained outside London through firms cramming into shared spaces, whereas in London, where the property market is less aligned to niche sector needs, firms also struggle with interactivity and property market information, but can manage their expansion needs by relocating from the cluster hubs, which is a threat to cluster sustainability. Adaptive behaviour on the supply side of the property markets was also more apparent in the non-London clusters. In both cases local champions stepped up to create needed niche-sector start-up space, and in Guildford landlords have had to bend to niche sector tenurial demands.

There was a noticeable lack of land use planning interventions in both non-London narratives. In Malvern, there was a lack of long-term provision of employment land, and in both Malvern and Guildford studies, there was a lack of Article 4 directions relating to the withdrawal of permitted development rights in terms of business uses compared with residential uses. Both are shown to have restricted the supply of appropriate workspaces. Conversely, in London, Article 4 directions have been implemented and have been a useful tool in terms of protecting appropriate workspace. The problem has been their slow implementation, which may have contributed to a loss of workspace stock at a time of need. It would appear that rather than a lack of planning tools, there may be issues relating to the institutional embeddedness of the planning system and political will which may have the strongest impact on cluster-related property markets. This study shows how demand factors are even more nuanced, reflecting property sub-markets relating to niche sectors and their localised working practices, property-sub market identification and alignment with clusters, and the implementation of land use planning policies.

These relatively novel ideas surrounding the recognition of the role of the local property market and the impact of its interplay with emerging clusters, add to our understanding of the role of the commercial property market in the microprocesses associated with the clustering process (Hamelink et al., 2000). Through the progression of the narratives, new evidence of numerous literary gaps have been highlighted, however in overall terms three key learnings have been developed. Firstly, in terms of cluster development, “place” and its associated complexities matter, and its circular causality with niche-sector business behaviour is demonstrated (Porter, 1990; Rosenfeld, 2002, Swann et al., 1998; Sölvell, 2008; Hospers et al., 2008; Uyarra and Ramlogan, 2012). Secondly, the responsiveness of land use planning to niche-sector workplace demands matters; and finally, the state and complexity of the local property market matters. A local property market should be understood on the one hand in terms of its niche sector homogeneity, and on the other, in a way that recognises the complexities and nuanced nature of the workspace supply situation, sub-markets, cycles and property market information flows. This

"brew" of factors needs to be added into the clustering equation, not hitherto having been recognised in what is a limited emerging literature as described in Section 2.4.3, and it can usefully provide a springboard for cluster development interventions, which are developed in the next chapter.

This recognised mix of property market–related factors adds a level of refinement to the ideas of D'Arcy and Keogh (1997), and the role of the "property market paradigm of urban change". Clusters are a central part of the urban economic spatial landscape which is subject to often highly complex local property markets, with different market responses and efficiency rates. Whilst the property literature is aware of how differences in property market efficiency rates affect competitiveness at the level of global cities and regional economies (Jones Lang LaSalle, 2019; Gibb et al., 2002), it is proposed that there is every reason to extend these ideas to the local level and to recognise their effect on both local economic development in general and clusters in particular.

The narratives provide rich primary evidence to support the need to develop our understanding of the microprocesses of an economy, businesses and individuals (Boschma and Frenken, 2006; Huggins, 2008; Pratt and Jeffcut, 2009; Nathan and Overman, 2013; Glaeser et al., 2012). They demonstrate the often unique characters of niche-sector clusters and how it is the highly granular nature and the entwinement of two dynamic forces – local niche sector business workplace needs with the local property market and all its complexities – that play a central role in cluster development.

Chapter 7 Study findings, contributions and conclusions

7.1 Introduction

The aim of this study was to explore the relationship between place and digital technology clusters, proposing that, even in today's virtual working environment, place has an important and under-recognised role to play in the development and characteristics of digital technology clusters. Three study objectives were presented (Section 1.1):

1. To enrich the evidence base of primary research into digital cluster development;
2. To develop a better understanding of the clustering characteristics of niche digital businesses; and
3. To evaluate the importance of place to niche digital cluster development and its potential in terms of cluster intervention approaches.

A broad exploratory approach, which focused on developing an understanding of business working practices, locational demands and the significance of their local built environments (Figure 3.1), was taken in order to meet the objectives and to provide the context for testing the study's broad theoretical hypothesis, that:

The built environment and associated property market institutions play an important role in the development of niche sector digital technology clusters.

The study was guided by two research questions:

- **How do niche sector technology business working practices and the built environmental features of place impact digital technology cluster characteristics?**

- **What are the features of the local built environment and associated property market institutions which afford or constrain digital technology cluster development?**

The research comprised the exploration and analysis of four case studies representing four digital technology clusters in the UK. Face-to-face interviews with clustering digital technology businesses provided the primary research data. These were undertaken during the period 2018–2019, prior to the COVID-19 outbreak, such that firm working practices and behaviours are typical of pre-pandemic and lockdown times. Three thematic exploratory investigations of the case studies were undertaken, the significance of the built environment in terms of the identified three

characteristics of clusters (Section 2.2.1): co-location, face-to-face interactivity and the interplay of the property market with cluster development.

The purpose of this chapter is to reflect and draw conclusions on the presented evidence. It is structured in a number of sections. 7.2 summarises and reflects on the findings of the study in the context of the research questions and addresses the theoretical hypothesis; 7.3 considers whether the study has met its objectives; 7.4 looks at the significance of the study's contributions to the literature, their potential impact and their policy implications; 7.5 summarises identified limitations of the study; 7.6 proposes follow up avenues for research and the final section 7.7 wraps up the thesis with some final thoughts.

7.2 Key findings of the study and confirmation of study hypothesis

By consolidating and reflecting on the thematic outputs presented in Chapters 4, 5 and 6, an overall informed response to the research questions is possible, which in turn informs the necessary testing of the study hypothesis. The findings are discussed below in terms of each research question.

7.2.1 How do niche sector technology business working practices and the built environmental features of place impact digital technology cluster characteristics.

The study explored each of the identified three key characteristics of clusters, niche sector business co-location, local face-to-face interactivity and the interplay of clusters with the local property market (Section 2.2.1). Drivers of co-location are found to be highly individualistic for each cluster and based on a mix of factors of varying importance and which are reflective of niche sector working practices. Central to co-location is the strong association of the niche sector businesses with workplace, which often plays an emblematic role in terms of firm identity. Traditional industrial locational factors also play an important role in co-location of the firms, including transportation connectivity (Simmie et al., 2002; Champion, 2014), supply chain proximity (Brydges and Hracs, 2019b), and the availability of appropriate workspaces (Segal Quince Wicksteed, 2001; Madelano et al., 2018). The idea developed by some cluster theorists (described in Section 2.2.3), that clustering takes place because of the need for knowledge (Storper and Venables, 2004; Scott, 2001; Polanyi, 1966; Nelson and Winter, 1982; Gertler, 2003), was only borne out in the Guildford case study. In this case obtaining employment-related information was seen as a priority and drove the participants towards the relatively uncontested renting of town centre workspaces, to take advantage of the local "buzz" and face-to-face interactivity which, for them, seemed to be the most effective way of transferring employment-

related information. In Malvern and Clerkenwell, co-location was a function of the availability of their preferred science park and converted old printing workspaces respectively, both of which were central to firm credibility and identity. Place branding was important for all clusters, with Malvern firms associating with the town's cybersecurity credibility, and the London games firms with Clerkenwell's prowess in terms of the advertising industry with which they seemed to associate. Localised face-to-face interactivity was constrained in both cases due to relative separation, in Malvern due to a lack of technical skills commonalities, physical connectivity and the design features of the Science Park, and in Clerkenwell due to the relative spread of the firms and the commuting lifestyle patterns of the maturing millennial staff. The London cybersecurity firms, which are often the marketing arm of a business based overseas or elsewhere in the UK, also co-located. This is due to a mix of factors: the need to be close to their City clients, the availability of flexible working spaces which have sprung up in the Shoreditch area, and enjoyment of being associated with the Tech City area. The local bars and restaurants served to provide them with a form of extended workplace for client meetings. The predominance of male locational decision makers is noted. The effects of this striking gender bias would be an interesting basis for future study.

A question arises as to whether any of these clusters have developed in a different place? It is postulated that this is unlikely, not only because the property market conditions and built forms are unlikely to be replicated, but mostly because of an identified, acute sense of identity with place. The study uncovered both an emotional attachment in terms of love of work which is associated with place, and the desire to obtain the credibility and kudos associated with their workplaces, defined as a combination of place, built form and the qualitative aspects of the workspace. This credibility assists the firms to attract skilled labour in a climate of digital skills shortages. This finding builds on the work on creative industries (Bank, 2012), and extends the findings to the more technological sectors, represented by the cybersecurity sector.

The characteristics of each niche sector were also demonstrated to have distinguishable effects on local face-to-face interactivity and knowledge flows. Local knowledge flows were related to employment, supply chain, technology, business support and workspace property market information. All forms were generally valued by all interviewees, but to varying extents depending on local niche sector working practices. It was noticeable how, in all cases, same-sector relationships predominated. Homogenous as opposed to heterogenous interactivity were the primary types of face-to-face interactivity in each of the clusters, which is contrary to the findings in studies by Vallance (2014) and He and Gebhardt (2013) on the games industries in Newcastle-upon-Tyne and Shanghai respectively. Both of those authors claim that games industries are likely to be in large urban centres where they enjoy Jacobean urban externalities. Only in the Guildford

case study was there any evidence of cross-sectoral interactivity and corresponding innovation, with two of the games companies having forged links and developed new products with the local racing car industry – which, notably, was not located in Guildford town centre. A plausible explanation for this observation is the relative maturity of the Guildford games cluster, added to the fact that the local economy is less diverse than that of London. Inter-cluster relationships may be easier to initiate, but they take time to develop, much in the way that any local community develops. The temporal element of cross-cluster linkages, together with the distinguishing local economic landscapes of provincial as opposed to metropolitan clusters, appears to be worthy of further investigation.

The above observations fit in with the study's findings regarding the role of "buzz". Niche-sector differentiation has added evidence to the ongoing literature debate surrounding the idea of a "buzzing locale" (Bathelt et al., 2004; Maskell et al., 2006; Storper and Venables, 2004). It was observed that not all niche sectors take advantage of the local restaurant and bar scene for meetings and may be more active in a local more virtual "buzz". The study shows that the service-orientated cyber companies of Shoreditch and the talent-hungry indie games companies of Guildford were involved with local "buzz", whilst for the Clerkenwell games firms, it was more about being associated with "buzz" than actually participating in it. This is a new way of looking at the role of "buzz" and fits in with the related points of the emerging field of place symbolism (for example Nathan, 2018). It is suggested that this is an area of study worthy of more attention. Whilst the study highlights the varying roles of local buzz, it has not interrogated how local virtual connectivity and virtual "buzz" may be related to or replace local "buzz" (Pratt, 2000; Grabher and Ibert, 2014; Bathelt and Turi, 2011), which is likely to be central to developing useful interventions and leveraging the clearly central role of "buzz" to clusters.

There seemed to be an evolutionary element to local face-to-face interactivity as proposed for the Guildford cluster and reflected in some of the evolutionary cluster models (Section 2.3.4). Similarly, a factor in the observed weak face-to-face interactivity of the London games cluster was that the firms were relatively young. Most notably in the games clusters, younger firms had different working practices and approaches to business from many of the more mature firms, which were likely to reflect the priorities of maturing millennials, possibly commuting and prioritising family life rather than a "loft living" work/lifestyle experience (Florida, 2002, 2012). The new firms tended to be more open and valued the business support afforded by sharing offices with others. It may be that a new generation of games companies, operating in the manner described in entrepreneurial ecosystems (Stam, 2016), is now coming through. This was less obvious in the cybersecurity sector, possibly also reflecting their sometimes more secretive working practices, but also highlighting that knowledge sharing is most valued between

professionals with skills commonalities. Games firms seem to have more in common with each other than the more mixed portfolio of skills represented in cybersecurity companies (Section 3.3.2). These observations highlight the niche sector nuances that exist within entrepreneurial ecosystems, supporting the work by Stam (2010). It was noticed that as the clusters mature, there is likely to be a step change in levels of collaboration and interactivity, as key firms, industry agencies or public sector initiatives start to take responsibility for networking events. In Guildford, networking is pub-based and vibrant, facilitated by local firms and supported by the Borough Council and UKIE; whereas in London, cybersecurity development firms meet through large firm and industry-led initiatives held in their own workspaces. Not only does the proximity and availability of interactive spaces have a role to play, as in Malvern, but so does time and the associated period for developing relationships and stages of collaboration (Atherton, 2003; Sunley, 2008). This study shows that it is not possible to generalise about the levels of collaboration, face-to-face interactivity and knowledge flows by life-cycle stage of firms, which has been a tendency of the literature. Each cluster has its own characteristics, and unless there is a driving need for specific forms of localised information, for example employment-related information in the Guildford games cluster, face-to-face interactivity whilst recognised and valued by all clustering firms, is not a given and develops over time. The rate at which it develops is dependent on the niche sector and the attributes of the local built environment, as summarized in the next section.

The study shows that there is a causal link between niche sector technology working practices and behaviours and components of the built environment. The two are intimately intertwined. This relationship produces clusters with unique co-locational characteristics, local face-to-face interactivity and development paths, as proposed in Section 2.2.1. An indicative ranking of cluster characteristics (1 – low, 5 – high) by case study cluster is proposed in Table 7.1.

Cluster	Co-locational density	Intensity of local face-to-face interactivity	Cluster dynamism
Guildford games	Dense in town centre: 5	Highly interactive: 5	Very dynamic, pulsating growth: 5
Malvern cybersecurity	Dense within Science Park: 5	Low levels of interactivity: 2	Slow organic growth: 2
Clerkenwell games	Diluted by other business uses: 3	Low levels of interactivity: 2	Fast growth, becoming more spread through expansion to peripheral areas: 5
Shoreditch cybersecurity	Diluted by other business uses: 3	Low levels of interactivity: 2	Fast growth, signs of intensification of clustering: 5

Table 7.1 Case study cluster characteristics rankings

These rankings are presented in a radar diagram, Figure 7.1, which helps to illustrate the different characters of the case study clusters.

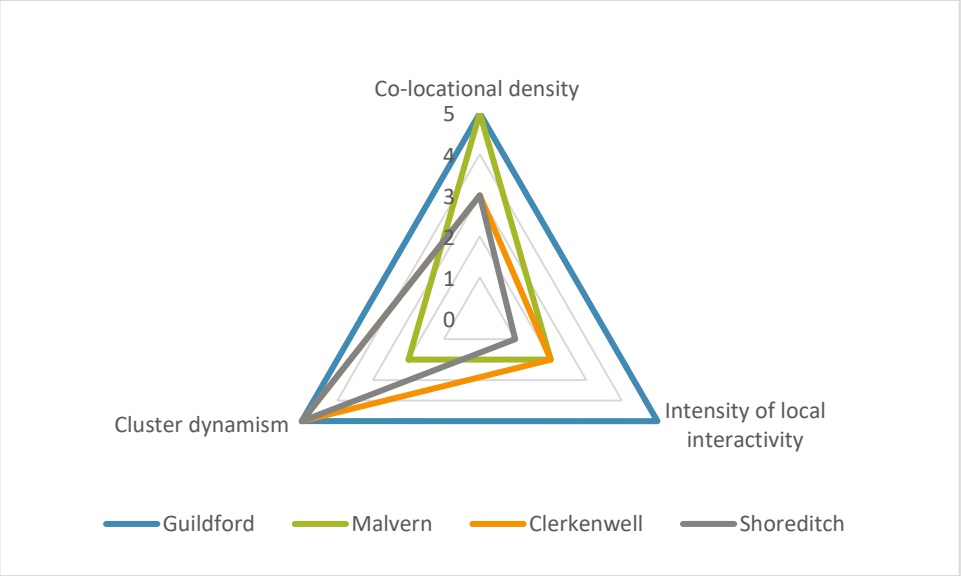


Figure 7.1 Radar diagram highlighting the specific characters of the case study clusters

Thus the idea of specific characters for clusters based on their three common attributes (proposed in Section 2.3) is validated. The analysis also suggests that the working definition of a digital cluster (Section 2.3.1) should be refined as follows:

A contextualised critical mass of niche digital businesses exhibiting a co-location, localised interactivity and dynamic evolutionary traits of varying intensities.

It is shown that the built environment has a significant role to play in respect of the intensity and variability of these attributes and it is this relationship, entwined with novel distinguishing commonalities of the niche sector digital firms, that is responsible for their separate characters. Working practice behaviours relate to variations in their reliance on scarce skills, spatial branding,

workspace needs, the use of public transport, and a preferences for niche sector interrelationships and community development, which are peculiar to digital technology clusters.

The effects of niche sector working practices and behaviours and the characteristics of the local built environment can usefully be combined into more detailed cluster diagnostic frameworks to probe the causative features of the built environment and also answer the second research question.

7.2.2 What are the features of a local built environment and associated property market which afford or constrain cluster development?

The second research question serves to specifically probe how the built environment affects digital cluster development. The thematic explorations provided insights into how the built environment has implications for cluster behaviours. These include the timely availability of a continuum of preferred workspaces to match business life-cycle needs; a density of built form, workspaces, bars, restaurants and networking spaces; and proximity to efficient public transport.

Table 7.2 has been developed through the consolidation of evidence from all three thematic chapters, focusing on identifying the features of the built environment which affect cluster development, using a simplified "affordance and constraint" approach.[35] Aspects of the built environment are recognised in the table as either affording (A) or constraining (C) clustering behaviours. Notes are also made in respect of adaptive measures taken by firms seeking to expand but maybe frustrated by a lack of local, appropriate workspace supply.

[35] Affordances were first defined as " the action possibilities posed by objects in the real world" (Gibson, 1977). Objects allow possibilities for action, or a need to adapt or constrain actions.

	Guildford digital games	London digital games (Clerkenwell)	Malvern cybersecurity	London cybersecurity (Shoreditch)
Distinguishable niche sector working practices	Indie PC-based. Volatile. Project-led. Heavy reliance on broad range of talent.	Mobile phone–based games. Often associated with media agencies. Incremental growth. Reliant on skills.	Development centre. Reliance on very skilled personnel. Diversity of products and skills.	Client-facing, generally serviced-based. Remote working practices. Development undertaken outside London or overseas.
Built co-locational environmental affordances and constraints	A: Availability of town centre workspace. A lack of competition for the compact work spaces without car parking. Conservation and flood protection policies. C: Lack of availability of workspaces for growing companies.	A: Clerkenwell proximity to media cluster. Availability of conserved, converted ex-printing works C: Lack of availability of workplaces and rising rents for growing companies.	A: Availability of science park workspace. Technology-supportive planning policy. C: Lack of availability of workplaces, particularly for growing companies.	A: Proximity to technological cluster. Availability of flexible working space. C: Lack of availability of private workspaces for growing companies.
Built environmental face-to-face interactivity affordances and constraints	A: Proximity of meeting places. C: Road congestion. Isolation of start-up space	A: Events. Proximity of meeting places. C: Relative isolation through mixed-use workspaces and large geographical area.	A: Events. C: Design and isolation of science park. Isolation of start-up space.	A: Events. Proximity of meet-up spaces. C: Mixed tenant population in flexible workspaces.
Adaptive behaviours to short supply of workspaces	Sharing and cramming of staff into workspaces.	Remote working practices in early stages. Relocation within London.	Sharing and cramming of staff into workplaces.	Remote working practices. Retention of London as a registered address.

Table 7.2 Summary of thematic study outputs

Built environment affordances for co-location relate to the local availability of preferred workspaces, varying by business life-cycle stage and constrained by their availability and increasing rental values. This central finding reinforces the need for cluster studies and interventions to pay more attention to the availability of appropriate workspace supply by niche sector over time, a requirement little recognised in the literature since Segal Quince Wicksteed's (1985) study of Cambridge. As discussed, affordances for local face-to-face interactivity relate to workspace design features and proximity to "meet-up" spaces, such as bars, restaurants, networking events and even pavements, within a relatively homogenous business population. These observations build on some of the early ideas of Jacobs (1969) and the importance of

"block size" in cities in order to facilitate serendipitous meetings and other ideas relating to the effectiveness of mixed, flexible working spaces in terms of cluster development (Moriset, 2013; Merkel, 2015; Madelano et al., 2018), and Martin's (2015) work into urban design features including outdoor meeting places and how they should be considered as extensions to the workplace.

Adaptive measures to facilitate the generally overwhelming desire to stay within a cluster, even when workspace supply is limited, vary between provincial and metropolitan firms. Guildford and Malvern firms would share workspace and cram their staff into town centre space or science park space respectively rather than relocate away from the towns. In London, where rental levels are more volatile and higher, there is correspondingly greater fluidity and choice of workspace solutions and location, due to the extensive area of the capital and more openness to remote working. This fluidity of firm location in the metropolis is supported by the firms' association with "London" as the primary place brand attractor rather than individual boroughs. Neither Clerkenwell nor Shoreditch has developed the same sectoral spatial identity as the Guildford and Malvern brands. The finding builds on other evidence in the study which found that cluster characteristics and microprocesses differ between provincial and metropolitan clusters, as discussed in the next section.

A clear lesson from the study is the complexity and dynamism of the process of cluster development. Chapter 6 explored the particularly volatile relationship between cluster development and the market for workspaces through the development of historical narratives. It seems that it is this interplay of forces which is at the heart of whether a cluster develops and how it behaves. Central to a place's ability to provide a sustainable continuum of workspace appropriate for the clustering firms' needs over time is the responsiveness of the local property market. This depends, as explained in Section 6.3.2, on three intertwined causative attributes of place: the local built form and the effect of planning policies; property values and competing markets and levels of local interactivity and the flow of property-related information.

Local built form and planning policies

The local built form was often key to the clustering firms' local identity. It was either protected or not by local planning policies, which had a demonstrable effect on the supply of preferred workspaces in each case study. Additionally it was shown in the Malvern case study how willingness to engage in forward planning by the local planning authority also has a marked effect on the availability of an appropriate supply of workspaces for local businesses. These observations add to a very small but emerging literature of the localised effect of land-use planning in cluster

development (He and Gebhardt, 2013, Osman 2015), and are worthy of more exploration if we are to provide adequately for the new generation of digital industries.

Property values and market composition

Chapter 6 provides evidence of the differential volatility of the case study property markets. The availability of appropriate workspace was both highly differentiated and varied at the local scale and was in constant flux. Whilst rental levels are usually recognised as being an indicator of the health of property markets, the Malvern case study demonstrated that this is not always the case. There may be other factors at play such as the relative homogeneity of the local economy or property market information flows. The heterogenous economy of London means that rental values have little relationship to the demands of cybersecurity firms, for example, but the firms benefit in terms of a greater choice of workspaces, albeit at a cost in terms of cluster consolidation, critical mass and identity. This evidence contrasts with a prevalent view in the cluster literature that growing clusters are likely to cause rental levels to rise (Marshall, 1890; Simmie, 2004).

Local interactivity and the flow of property related information

The discussion relating to the importance of property market information flows (Section 6.3.2) is relatively novel, albeit it supports some of the generally overlooked ideas of cluster development (Veblen, 1898; Myrdal, 1957), resurrected by Malmberg and Maskell's (2010) model of the "chain of cumulative causation" of cluster development. The role of circulating and reinforced knowledge flows feeds into an idea of treating cluster dominated economies as a "locale" (Guy and Henneberry, 2000; Vinodrai, 2006), a place inclusive of its knowledge resources. Furthermore, the idea of locally circulating property market information adds a level of refinement to the recognition of the central role of the property market in the adaptive urban efficiencies of urban development discussed in Section 2.4.2 (D'Arcy and Keogh, 1997), which has hitherto been applied at regional and global city spatial levels (Gibb et al., 2002; Jones Lang LaSalle City Momentum Index, 2019). It is proposed that the idea could usefully be applied at the local level as discussed in the following section.

It emerged from the study that, if they are working effectively, the property market–led causative factors will be part of a cycle which may reinforce "islands of development" (Guy and Coaffee 1999), validating the built environmental–based model which depicted the circle of causation of cluster development based on property market information flows in Figure 2.4. The built space needs of niche sector businesses are shown to be highly differential and dependent on the responsiveness and efficiency of the local property market. As technology industry life cycles are

more volatile than ever before (Section 2.3.5.2), it is essential that the built environment is fit for purpose and can be equally responsive. Thus it is evident that a burgeoning healthy cluster will be reliant on fine-grained fast-flowing property information and locally relevant policy and property market responses, much as promoted by Cameron and Fleming (1990) and Guy and Henneberry and Guy (2000). The demand-supply relationship of local property markets is far from rational and straightforward (Massey, 1990), and varies widely by place and over time (Henneberry et al., 2008). Property market information flows may be key to unlocking this potential blockage to cluster development and economic development generally, and it is suggested that the matter warrants in-depth study to confirm how digital firms obtain property information, exploring the issues and possibilities for improvement.

7.2.3 A way forward

The model and identified property market causative factors of cluster development are tested by application to the four case studies through the framework in Table 7.3.

	Games clusters		Cybersecurity clusters	
	Guildford	**Clerkenwell**	**Malvern**	**Shoreditch**
Distinguishable and associated built form	Town centre workspace Distinctive start up space	Ex-printing works Distinctive Hub (UKIE)	Science Park Distinctive start-up hub	Non -distinctive space Collaborative workspaces No hub
Degree of heterogeneity of localised economy	Low, games predominate	High, creative bias	Low, technology bias	High, technology bias
Facilitative planning policies	Protective policies assist. Need to consider Article 4 directions to protect business workspaces	Protective and Article 4 direction in place	Need for forward planning of employment sites	Article 4 direction in place
Level of local face-to-face interactivity	Strong	Strengthening, UKIE is useful	Very weak	Strong (only with clients)
Resultant property market efficiency	Strong	Weak	Very weak	Moderately strong
Private sector developer interest in providing niche sector workspace	Yes	No	No	Yes
Local facilitative industry champions?	Yes	UKIE	Yes	No
Comment and Interventions	Efficient and effective property market. Need for proactive workspace monitoring and land use planning.	Interventions to facilitate local interactivity in general and property market information flows.	Interventions to assist strengthening interactivity and supporting very niche sector business development. Develop property market information flows. Need for proactive workspace monitoring and land use planning	Encourage niche local interactivity in general and property market information flows. Need for distinctive cluster hub.

Table 7.3 Built environmental causative framework applied to case study clusters

The framework helps to focus on weaknesses in factors contributing to local property market efficiencies and highlights potential bespoke interventions befitting the specific characteristics of each cluster. The interventions vary from the need for better forward planning and planning policies, property market information flows and developing distinctive hubs to mechanisms for heightening local interactivity. Such a framework would reflect on Nathan and Overman's (2013: 398–399) ideas for a property market approach to cluster support and development, which they thought would provide the best way forward in terms of developing cluster interventions.

7.2.4 Section conclusions

The research questions have helped to highlight the importance of recognising the nuance and granularity of clusters in their localities over time. Cluster models need to be more complex and adaptive than has hitherto been recognised (Martin and Sunley, 2011). Accordingly, generic, cloned cluster development interventions are likely to be inadequate and we need to be alert to local niche sector working practices and culture and the nature and nuances of their place setting, including the patterns of workspace supply, much in the way as advocated by Hamelink et al. (2000).

The responsiveness of the property market is shown to be a central factor of the cluster built environment which deserves more research attention. Furthermore the validity of a framework based on the causative property market findings of the study proposed in Section 2.4, as a basis for interventions has been developed. It is clear that the built environment and associated property market institutions, play an important role in the development of niche sector digital technology clusters. The study's theoretical hypothesis is confirmed.

7.3 How has the study met its objectives?

The study has generated numerous findings. It is considered that it has fulfilled its overall research objectives namely:

To enrich the evidence base of primary research into digital cluster development

The study is unusual in that it takes a multiple case study approach, including analyses based on historical narratives, which has lent itself to the production of rich, transferable primary evidence and often new learnings. The evidence is both novel and usefully localised, granular and temporal which is suited to the dynamic nature of digital clusters (Section 2.3.4).

To develop a better understanding of the clustering behaviour of niche sector digital businesses

The study showed that niche sector digital sectors are valid basis for studying clusters. It illustrated how such firms, with their distinguishable working practices and cultures, have corresponding implications for both co-location and local face-to-face interactivity. Niche sector as a variable appears ultimately to be responsible for differential values placed on co-locational drivers, that is supply chain needs, knowledge flows, labour pooling needs and the emblematic value of workplaces.

To evaluate the importance of the built environment in niche sector cluster formation and its potential in terms of cluster intervention approaches.

Two key land-based mechanisms of the built environment, workspace supply and public transportation connectivity, stand out in terms of their effects on affording or constraining niche sector cluster development. The former became the focus of the study, with the interplay of the supply of workspace and business development recognised as being central to cluster development. It was shown that whilst developing an understanding of local property markets may be a key to a cluster's success, planning policies and property market information flows have an important role to play and may provide useful interventional levers.

7.4 What are the study's key contributions, what is their significance and their application to cluster development interventions.

The exploratory nature of the study has led to the exposure of numerous findings which are significant in terms of their contributions to cluster theory debates, evidence gaps and the potential for policy and support interventions. These contributions have been highlighted in the conclusions of each of the analysis chapters, 4, 5, and 6 and are consolidated below.

7.4.1 Additions to ongoing literature debates

The study contributes to two continuing debates: firstly that of local face-to-face interactivity, the importance of homogenous or heterogenous linkages and the role of "buzz" (Duranton et al., 2001; Storper and Venables, 2004; Bathelt et al., 2004; Grabher, 2007; Nathan and Vandore, 2014), introduced in Section 2.2.3 and secondly the dynamism of clusters and the effects of business and cluster life-cycles (Klepper, 1997, 2007; Sölvell, 2008), as first described in Section 2.2.4.

Local face-to-face interactivity

The study shone light on why some clusters are more interactive than others, an area of the literature which has remained controversial and thin on evidence (Duranton and Puga, 2003; Sunley et al., 2011; Storper and Venables, 2004; Storper, 2013; Lindqvist et al., 2008). Niche sector working practices and the characteristics of place are fundamental. It could be that the effects of varying and unique local economies and cluster relatedness are appropriate to different cities with their own unique industry bases and spaces. To date this has been an unresolved debate in the literature, which has generally resulted in a "one size fits all" approach to city clusters and interventions – resulting in "clone-like" city centres instead of celebrating differences between

and within cities and encouraging more appropriate nurturing environments for economic development, as demonstrated by Wagner and Sternberg (2004). Local face-to-face interactivity with same-niche-sector professionals is valued by all firms but to different degrees, depending on niche sector working practices and business models. The level of "buzz" reflects this in part, but "buzz" is also valued in emblematic terms, providing an attractive backdrop for firms even if their participation is limited. The built environment entwined with the level of homogeneity of the business population is shown to play a major supporting role provided proximate meeting-up spaces are available.

The dynamism of clusters and the effects of business and cluster life cycles

Cluster evolution and business life-cycle evolution were recognised as possible explanations for differential cluster behaviours. The study outputs help to illustrate several unknowns in terms of digital cluster development as raised in Section 2.3.6, including the question of why some clusters take off and others don't (Section 2.2.4). It was shown how business spinouts were responsible for new firm development in provincial areas, whereas cluster development is more incremental, heavily based on home and remote working for the London cases. In all cases the supply of appropriate workspaces was key in terms of cluster inception and development, matching the requirements of businesses through their evolution. A new finding is the need to focus on the workplace requirements of maturing companies, an aspect of cluster evolution rarely honed in on, yet seemingly critical. The lessons are that a portfolio of niche sector–appropriate workspaces should be available if the cluster is to grow. This study was not set up specifically to delve into the area of business life-cycle needs, but it is felt that it deserves more exploration.

7.4.2 Cluster theory evidence gaps

The study provides evidence which will contribute to cluster theory, helping to fill some of the evidence gaps, including the mechanics of firm co-location, the importance of "place", and the role of the property market in cluster development. Again each finding will add significantly to a policy maker's cluster development tool kit.

The mechanics of co-location

The research revealed spatially driven commonalities between niche sector digital technology businesses, including the value placed on the emblematic appeal of workplaces, their reliance on scarce skills and the common recognition of developing a labour pooling effect, the popularity of public transport, and the common value of a niche sector community and knowledge flows. These identified commonalities are shown to be variously applicable for each cluster.

The less tangible locational needs of entrepreneurial firms have been documented before in respect of creative firms (for example Haughton and Allmendinger, 2008; Clare, 2013; Pratt, 2011; He and Gebhardt, 2013), but not in terms of the more functional workplace preferences of the cybersecurity sector, which serves to help balance the bias of the evidence base (Van Heur, 2010a).

The importance of place in cluster development models

The study reinforces the need to incorporate place in cluster development studies, adding to a very limited and recently emergent literature (for example Osman, 2015; Nathan, 2019). The focus on the property market and the urban planning policies provides practical policy levers which can be usefully exploited to expand cluster development interventions. The less tangible locational factors, including the emblematic attraction of workplace and the importance of property market information flows, are relatively novel and could provide new avenues for research and policy development.

Motivated in part by the 1982 Manchester based study of Fothergill and Gudgin (Section 1.0), a major contribution of this study is to develop an understanding as to whether the built environment of digital technology businesses is fit for purpose and provides a fertile seed bed for cluster development. It explores the extent to which the built environment has supported these clusters, giving insights into the identified utility of appropriate workspace provision and good transportation connectivity. The outcomes are unique for each case study, showing that the respective built environments are more or less supportive, albeit adaptive behaviours are apparent by both cluster incumbents and also in some cases property market responses. The study highlights gaps in the respective built environments and identifies possible interventions – particularly in the form of property market responsiveness and efficiencies to help make them more adaptive. The study uniquely identifies the parts played by built form, planning policies, rental values, property market information flows, and the need to understand the distinctiveness of these attributes by place. It helps to redress the balance away from the city-centric cluster focus of the New Economic Geographers described in Section 2.2.1 (for example Duranton and Puga, 2003; Storper and Venables, 2004; Giuliani, 2007). It shows that clusters can be just as effective – or even more so – in provincial areas as in metropolitan areas. The value of clusters to local economic development is likely to be relative to the size and heterogeneity of the local economy. Duranton (2011) poured scorn on the importance of clusters in larger urban agglomerations; the London case studies confirm that they can successfully develop, but that they face greater obstacles to their establishment and sustainability than the non-London clusters.

7.4.3 Consolidated significant contributions and new possibilities for cluster development interventions.

This section consolidates the most significant identified contributions of the study and uses them to propose cluster policy interventions. They relate to the recognition of the central role of three built environmental–related factors on digital technology cluster development, the interplay between workplace and property markets, the importance of land use planning on cluster appropriate workspace supply and the importance of local property market responsiveness and its association with localised cluster face-to-face interactivity. Each is described below.

The interplay between workplace and property markets

The most significant contribution is the recognition of the importance of the interplay between workplace demands of the growing digital businesses and ability of a particular location to the supply of appropriate life-cycle stage workspace which would seem to be the crux of the question over whether a cluster can develop. Whilst there is a large literature which has investigated the role of the property market in urban competitiveness (for example Evans, 1995; Keogh, 1996; D'Arcy and Keogh, 1999), the effects at the local level appear to have been overlooked – and especially the recognition of the "ebb and flow" effect on the co-evolution of the local property market and local cluster development. The findings of this study will add to the recognised need to develop our understanding of place related microprocesses (Porter, 1990; Swann et al., 1998; Rosenfeld, 2002; Hospers et al., 2008; Sőlvell, 2008; Uyarra and Ramlogan, 2012). Interventions accordingly need to be local and nuanced in terms of industry built environmental needs.

The importance of land use planning on cluster appropriate workspace supply

The study highlights how the supply of workspace is very much influenced by land use planning which is a key component of cluster development that is rarely recognised. The study also contributes evidence to the debate surrounding the effects of planning policy lock-in on industry change dynamics (for example Needham and Low, 2006). It is shown that effective localised workspace portfolio monitoring and forward planning are key cluster management tool.

Local property market responsiveness

The study shows, perhaps for the first time, that the operation and responsiveness of the local property market is pertinent to cluster development. It is proposed that heightened localised property market responsiveness may be associated with highly interactive and "buzzing" clusters, and this association is proposed as an area of more in-depth study. Identification of the local gaps in property market information flows may provide a useful pointer for the moulding of cluster

development interventions. The proposed built environmental based model of cluster development (figure 2.4) has been validated suggesting that the role of property market information flows deserves more attention. Questions remain to be answered, including: How does it circulate? What is the role of local commercial agents? Where are the information gaps? How can efficiency rates be increased, especially in times of economic stress? Answers to these questions could usefully add to the evidence on the micro-dynamics of clusters and point to simple intervention possibilities as well as contributing beneficially to the city competitiveness literature.

7.5 Limitations of the study

There were several recognised limitations to the study including potential confirmational bias and interviewee bias.

Confirmational bias

The study has gathered observations regarding the attributes of digital clusters and how they are impacted by their built environments. It was noted that interviewees were generous regarding the positive benefits of their chosen locations, rather than dwelling on the negative aspects, a form of confirmation bias (Watson, 1962). It was clear that often interviewees were seeking unsurprisingly to legitimise their decisions, mistakes could have been made and we all like to think we have made the “best of things”. My background as a chartered surveyor may have biased the outputs such that the interviewees sought to overemphasise the importance of the built environment or indeed found it easier to express their opinions on it, it is difficult to know. Bias is generally accepted as being implicit in an interview-based research approach and not considered to be significant. Inevitably, all interview based research will, and possibly should encapsulate these views which in the end are reflective of the “subjective views, beliefs and thoughts of the individual respondent” (O’Connell Davidson and Layder, 1994: 125). Subjective views are the lens through which operations and business activities are undertaken.

Interviewee bias

A further area of potential bias is the limitation of the interviewees to only the CEOs of businesses. The interviewee sample base should perhaps have been expanded to include additional interviews with employees to help balance the sample group. For example, whilst CEOs of mature companies might be cautious about too much interactivity with other same-niche-sector businesses for fear of losing staff, the younger staff might well think otherwise and enjoy this form of interaction.

It is further acknowledged that the outputs of the study might be better balanced by including interviews with niche sector firms located outside clusters to compare the results. Additionally, the views of entrepreneurs whose businesses had failed in the given locations would ideally have been useful.

A noticeable issue associated with interviewee sampling is that rarely would a “large” firm respond to invitations to participate. The study was therefore biased towards the opinions of the CEOs of small and medium firms. Since size and maturity of company did emerge as being potentially meaningful (Section 4.3.2), it is suggested that a full cluster profile of businesses would need to be part of a wider study. How to contact and arrange interviews with the larger companies will, however, remain a challenge.

7.6 Suggestions for further study

This exploratory study has exposed and described many avenues for further study, which are described amongst the study’s findings in Section 7.2 They include investigations into the temporal elements of relationship formations in and beyond clusters (identified in Section 5.3.1); the significance of “buzz” and “virtual buzz” in clusters (identified in Section 5.3.1); the role of local land use planning policies in digital clusters (identified in Section 4.3.3); the effect of the masculinization of locational decisions (identified in Section 4.3.3); the needs of mature businesses in clusters (identified in Section 5.4) and the importance of property market information flows in cluster development (identified in Section 6.3.2).

As described in Section 7.5, a deficiency of the study is the lack of knowledge about digital niche sector firms located outside of a cluster and how they compare with those inside the clusters. A useful immediate next step, which would also assist in clarifying some of the observations in the current study, would be to undertake a more comprehensive comparative quantitative modelling study based on the same clusters but sampling firms both inside and outside of clusters. Extra distinguishing layers could be included such as firm size and age, which would help confirm the business life-cycle observations in this study, together with more details of their workspace locational history. It is possible that the in-cluster bias of this study self-selected these variables from the study. An expanded study would assist in shedding more light on this current output.

Finally, it is to remember that the built environment is only one aspect of place chosen for investigation, and until other aspects (such as social networks, political institutions, community cohesiveness or professional institutional development) are investigated, its role and relative value cannot be totally assumed.

7.7 Final words

The study highlights the uniqueness of digital clusters and that they should be viewed as complex adaptive systems (Martin and Sunley, 2011), evolving and adapting synergistically with the built environment. The clusters start for differing reasons and are sustained through competitive business practices which often relate to the need to appear attractive and credible. A big part of this practice is reliant on workplace image and location, which is central to a built environmental–based model depicting the circle of causation of cluster development (Figure 2.4). Psychology and collective taste remain as important or more so than they were for the previous business economy:

> *underneath all economic laws, the final basis of human action is psychological, so that the last stage of analysis of the problems of the structure of cities, the distribution of utilities, the earnings of the buildings which house them, and the land values resulting therefrom, turn on individual and collective taste and preference, as shown in social habits and customs.* (Hurd, 1903, reprinted 1979: 17)

Digital firms demonstrate and reflect a "collective taste" based on digital niche sector in property and location, which appears to feed into cluster development. This requirement makes them particularly sensitive to the dynamics of the workspace property market, such that local interactivity and property market flows are central to their development.

The evidence strongly points to the need for local solutions to local economic problems (Storey, 2003; Jacobides et al., 2006), of which the workspace property market is a central feature. Back in 1990, Healey and Nabarro observed that

> *if public policy is to become more efficient and effective in achieving its objectives, then it is essential to build a richer and more fine-grained understanding of the way local property markets intersect with local economic development and political-institutional conditions.* (Healey and Nabarro, 1990: 195)

This study reinforces the need to develop this understanding. The importance of invoking a more focused, fine-grained approach to cluster research is demonstrated if we are to create a built form that is truly reflective of the workplace requirements of the digital era.

A. Summary tables of cluster theory development by academic discipline

A.1 Economics literature

Field of literature	Examples of key authors	Cluster model type	Focus and addition to the literature	Scale	Interest in spatial processes	Main criticisms
Classic models	Adam Smith, 1808	Industrial districts	Areal specialisation	Local	Recognition of the diversity of place	
	Marshall, 1890; 1920	Industrial districts and industrial localisation	Industrial localisation; industrial districts; sharing of knowledge; competitiveness Labour market pooling	Local	The uniqueness of place	Static and inward looking
Industrial Location Models	Perroux, 1955	Growth poles; urbanisation processes		Regional	Very little	Inward looking, exaggerated local benefits
Neo Marshallian – the Italian school	Florence, 1948	Industrial districts	Recognition of dynamic system, and impact of embeddedness. Role of trust and behaviours and a local way of doing things	Local	Local institutions but not spatial processes	Abstract and static
New Trade Theory	Krugman, 1991	Clusters	Competitiveness; agglomeration economics, knowledge dynamics; institutions and lock-in effect	Regional	Lack of interest in local scale	Lack of empirical data

Agglomeration economics and knowledge flows	Saxenien, 1994 Baptisma and Swann, 1990	Cities, clusters, milieux	The role of knowledge diffusion particularly in the context of innovation management	Regional	Geographical basis, place becomes a focus but no interest in microprocesses	
New Endogenous Growth theories	Romer, 1986; 1991	Clusters	Innovation; knowledge spillovers; lock-in effect; the local milieux	Regional	Geographical basis but no interest in microprocesses	Lack of empirical data
Evolutionary economics	Schumpeter, 1934; Nelson and Winter, 1982; Jacobs, 1969	Clusters	Dynamic; evolutionary; institutional basis recognised	Regional	Recognition of diversity and importance of microprocesses	Lack of empirical work

A.2 Strategic Management literature

Field of literature	Examples of key authors	Cluster model type	Focus and addition to the literature	Scale	Interest in spatial processes	Key debates & criticisms
Strategic Network Theory	Jarillo, 1988; Meleki, 1990; Mytelka, 1991	Networks	Role of networks & learning processes in firm innovation processes	Regional/ local	Interest in local socioeconomic environment, embeddedness	Lack of empirical research
Network theory	Granovetter, 1985; Dyer and Singh, 1998; Jones, Hesterly and Borgotti, 1997	Networks (central clusters a subset).	Knowledge flows	Regional	Abstract, lack of geography	Lack of empirical research Relationships, networks and clusters unclear Static
Industrial operations Management theory	Frohlich and Westbrook, 2001; Nunnally, 1978; Miller and Roth, 1994; Porter, 1998	Supply chain clusters	Importance of access to resources and efficiency of supply chains	Regional/l ocal	Some interest in location of firms in context of access to resources	Very firm-orientated
Marshallian Localisation economics	Porter, 1990s	Clusters	Firm based; competitiveness and knowledge led	National regional	Acknowledged but not investigated	Lack of empirical basis. Over generalization
Evolutionary economics	Schumpeter 1934; Boja; Ketels; Sövell 1950–present	Clusters	The complexity and heterogeneity of firms and place	Regional, some local		Lack of empirical data and comparative studies

A.3 Economic geography literature

Field of literature	Examples of key authors	Cluster model type	Focus and addition to the literature	Scale	Interest in spatial processes	Key debates & criticisms
New Economic Geography	Duranton and Puga, 2003; Storper & Venables, 2004; Giuliani, 2007	Clusters	Knowledge flows, exogenous & endogenous. Suggestion that city-based clusters may perform a different function to peripheral ones.	City	Some understanding of the negative effects of agglomeration Impact on clustering is not explored	Role of endogenous & exogenous knowledge flows Overemphasis on role of city in economic development
Neo Marshallian; Third Italy	Sunley, 1992; Asheim, 1994; Camagni, 1994	Industrial districts	Recognition of dynamic system, and impact of embeddedness. Role of trust and behaviours and a local way of doing things	Local	Local institutions but not spatial processes	Abstract and static
Evolutionary economic geography	Maskell and Malmberg, 1999; Boshma and Martin, 2006	Clusters	The complexity and heterogeneity of firms and place	Regional/ local	Recognition of need to understand microprocesses	Lack of empirical data and comparative studies

B. List of interviewees

B.1 Digital games interviewees, Guildford case study

	Role of interviewee	Location of meeting	Date of interview
1.	Founder & CEO	Office, Farnborough	18/12/2017
2.	CEO	Office, Guildford	12/3/2018
3.	Executive director	Office, Guildford	30/11/2018
4.	Founder & director	Phone	23/11/2018
5.	Founder & director	Phone	12/12/2018
6.	CEO	Office, Guildford	8/1/2019
7.	Managing director	Office, Guildford	11/1/2019
8.	Managing director	Office, Guildford	14/3/2018
9.	Joint managing director	Office, Guildford	12/12/2018
10.	Founder & CEO	Phone	8/1/2019

B.2 Digital games interviewees, London case study

	Role of interviewee	Location	Date of interview
1.	Founder & CEO	Office, Clerkenwell	26/6/2019
2.	Founder & operations director	Office, Clerkenwell	26/6/2019
3.	Design director	Office, Clerkenwell	26/6/2019
4.	Creative director	Office, Clerkenwell	2/5/2019
5.	Freelance creative director	Restaurant, Shoreditch	24/5/2019
6.	Co-director	Phone	22/5/2019
7.	Founder & CEO	Phone	23/5/2019
8.	Managing director	Office, Finsbury Park	14/5/2019
9.	Technical director	Office, Clerkenwell	14/5/2019

10.	Managing director	Phone	16/5/2019
11.	Founder & director	Café near office, SE1	2/5/2019

B.3 Cybersecurity interviewees, Malvern Case study

	Role of interviewee	Location	Date of interview
1.	Founder & CEO	Office, Worcester	27/2/2019
2.	Director	Office, Malvern	25/1/2019
3.	Founder & CEO	Phone	22/1/2019
4.	Founder & CEO	Office, Malvern	25/1/2019
5.	Founder & CEO	Café, Worcester	27/2/2019
6.	Founder & CEO	Phone	21/2/2019
7.	Managing director	Office, Malvern	23/2/2018
8.	Founder & CEO	Office, Malvern	23/2/2018
9.	Business development manager	Office, Malvern	23/2/2018
10.	Technical director	Phone	25/4/2019

B.4 Cybersecurity interviewees, London case study

	Role of interviewee	Location	Date of interview
1.	CEO	Phone	19/7/2019
2.	CEO	Conference & phone	29/5/2019
3.	Product marketing manager	Phone	29/5/2019
4.	Cyber vendor	Phone	31/5/2019
5.	Cyber vendor	Phone	6/6/2019
6.	Head of sales	Phone	6/6/2019
7.	Founder & CEO	Conference & phone	6/6/2019 & 13/6/2019
8.	Founder & CEO	Conference	6/6/2019

9.	Founder & CEO	Conference	6/6/2019
10.	Director of business development	Conference	6/6/2019

C. Interview details

C.1 Business interview Guide

The role of the built environment in the development of digital technology clusters,

PhD research study, Marion Payne, University of Southampton

Introduction; background to interview and objectives of the study. Offer to share outputs. Guarantee anonymity.

Interviewee information:

Date:

Name:

Position in co.:

1. Business Information	
a) Name:	
b) Address	

c) Tel: nos.	
d) Status: (public. Ltd. Etc)	
e) Product/service:	
f) Nature of process/processes:	
g) Description of sub-sector/product area:	
h) Turnover	
i) No. of employees	
j) Ratio professional/admin' staff	
k) How is the company structured?	

Comments/extra points regarding company background and operations

Company history:

a) When started?	
b) Where started? Discuss locational decisions	

c) Has the business relocated? Why?	
d) Growth in no of employees?	
e) What is their travel to work area?	
f) How many products do you have?	
g) How many products do you develop per year?	
h) How has the product/s changed?	
i) Would you say the company is very competitive? Rank /5	
j) Would you say the company is very innovative? Rank /5	
k) Discuss maturity of the co. relative to its inception.	
l) Is there a strategy for growth? Where will the co. be in 5 years' time? What is this dependent on?	

<u>Other points regarding the evolution of the company:</u>

2. Cluster focus: Introduction: discuss the meaning of a cluster generally and what is recognised locally

- Discuss and fill in the following table, who are the main customers, supply chain collaborators, competitors and any other relevant organisations and where they are located?
- What is the main means of communication and interaction?

	Name, if possible, if not, type of company	Location i.e. within or outside of the cluster?	Communication method
Customers			
Collaborators			
Competitors			
Other			

How important is it to you to be located in this cluster?

Has your relationship with the cluster changed over time?

Is it likely to change in the future?

Comment /extra points?

2. **Built environment:**

a) Discuss what is meant by the built environment, generally, and introduce the specific aspects see below.
b) What is the company's built environment requirements to day, in the past and in the future? Fill in the table below:

	Past	Current	Future
Business space needs			
Infrastructure needs			

Specific questions:

The Commercial property market*:* (defined as the market for space as required by the company to function effectively)

- In the light of your ideal requirements, what points would you like to make re. the commercial property market in this locality and how it affects the business in the past, currently and potentially in the future? Include physical space, legal and financial aspects.

- What are the key issues?

- Are there likely to be changes in the future?

- What proportion of your turnover relates to the property rent?

a) ***Infrastructure*** (aim: to explore the impact of infrastructure on the company both qualitatively and financially, now and over time)

Discuss the concept with the interviewee and fill in the table below:

Specifically:

Broadband services	**Comments (include time element)**
Road and transportation	
Housing	
Other	

b) ***Local business rates and incentives,*** (aim: to understand which land related taxes or incentives are affecting the business development now and over time)

Discuss the concept generally with the respondent

- Comment on business rates now and over time.

- Are there any local grants or incentives? Discuss

- Do you have any suggestions for the Council?

- Other points?

c) ***Planning system,*** (aim: to understand how the planning system is viewed by the respondent, and how they see it affecting their business.)

- Are you aware of local planning policies?

- In what way do they impact the business?

- Has the company participated in the local plan process?

- Do you have any comments on place making aspects pf local planning?

- Other points you would like to make

d) ***Consolidation of the interview:*** (aim: to bring all the information together in the light of the specific questions and time to consider all the component parts and produce a concluding simplistic cost benefit analysis)

Please list the main costs and the benefits of the cluster and its built environment on your business.

List	*Cost*	*Benefits*
Cluster		
Built environment		

A final evaluation:

- Do any of the above impact your company so much you might consider a move?
- How much worse does it need to get before you would consider moving?

e) **Other:** (aim: to pick up anything other issues affecting the business that the respondent feel need to be highlighted)

What issues do you feel this questionnaire has overlooked?

Thanks for your time

Agree and discuss how the feedback will be presented.

C.2 Secondary data supplementary conversation details

	Guildford	**Malvern**	**London**
Commercial agent	Face-to-face 15/1/18	Phone 4/4/19	Phone 4/6/19
Commercial agent	Phone 10/1/19	Phone 4/4/19	Phone 4/6/19
Commercial agent	Phone 8/1/19, 31/1/18, 8/12/19	Phone 4/4/19	Phone 4/6/19
Commercial agent			Phone 18/10/19
Commercial agent			Phone 18/10/19
Local authority	Face-to-face 29/6/18	Phone 12/4/19 Phone 12/4/19	Phone 18/10/19 Phone 18/10/19
Workspace manager	Phone 12/12/18	Face-to-face 21/1/19 Phone 3/4/19	Phone 13/6/19

Estate Agents and Chartered Surveyors

Local and national agents were asked to corroborate the quantitative property market data from a local market and national market perspective, including the sales and leasehold market, commercial and residential markets; the developer market and the investment market. Questions included:

- What are your observations regarding the property market needs of the local digital community?
- Can you comment on my observations (from stage 1)?
- What are your observations regarding this market, in the past, now and in the future?
- Do you have any comments on aspects of this quantitative data (describe findings from quantitative analysis)?
- Do you have any comments regarding local planning and infrastructure inputs?
- Can you identify specific developers and investors who are engaged in this market?
- Are there any other observations that you like to make?

Spatial planners

The aim was to ascertain how actively local authority town planners are engaged with the digital technology community and supplement my own observations regarding relevant local planning policies and interventions. Questions included:

- What type of engagement do you have with the local digital community?
- Are you aware of their local property and infrastructure needs? Describe the needs as understood from stage 1
- How are these needs being taken into account in the emerging Local Plan?
- Has the employment land review specifically looked at the needs of the digital community in the future?
- Does the authority have an economic development department?
- How well are the plans of the economic development department integrated with the emerging local plan?
- What are the issues and how can they be overcome?
- Are there any other observations that you like to make?

Local authority economic development, estates and valuation departments

The aim was to understand the role of the local authorities in providing incubator space and other business space; setting business rates or incentives and providing infrastructure or other support to the digital community. Questions included:

- What type of engagement do you have with the local digital community?
- Are you aware of their property and infrastructure needs? (describe the needs as understood from stage 1)
- Are you able to facilitate these needs?
- What are the issues and how can they be overcome?
- Are there any other observations that you like to make?

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