THE CHANGING GEOGRAPHY OF DATA CENTRES IN THE UK

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Abstract

The continuing growth of digital technology has been accompanied by an explosion in digital data generation. This data is processed, stored, managed and exchanged in data centres, which have become the driving hub of the economy and in some ways of society. This paper outlines the origins and characteristics of data centres and offers an exploratory discussion of their locational dynamics and their changing geography within the UK. The findings reveal that while data centres were initially concentrated in London a range of new urban, suburban and remote rural locations are becoming increasingly important. That said while the geography of data centres may be changing the need to design ever more sustainable centres, that increase energy efficiency and reduce carbon emissions, seems likely to remain constant.

Keywords Data Centre, Changing Geography, UK.

Introduction

The continuing growth of digital technology in an ever-expanding range of business, government and social activities has been accompanied by an explosion in digital data generation. This data is processed, stored, managed and exchanged in data centres, which have become the driving hub of the economy, and in some ways, of society. The Internet; email traffic; social networking sites; streaming sites; data processing; online retailing; credit and debit card transactions; electronic car parking, speed cameras and congestion charging; freight and parcel tracking by couriers; insurance documentation; and medical records all reply on data centres. The Telecity Group (2011), one of Europe's leading data centre companies, asserts that data centres are *'at the heart of the digital economy.'* More generally the development of data centres must be seen within the context of globalization and geography of producer services. Globalisation is often seen to foster the integration of markets (Herod 2012) but Alderson and Beckfield (2012) have argued that *'globalization has, in part, at least, been a fundamentally implosive rather than explosive process* with increasing globalization leading to increased agglomeration within a small number of locations. In exploring the locational strategies of advanced producer services Derudder and Witlox (2004) have identified a *'qualitative shift in the relation between urbanization processes and localization strategies, albeit it that the centrality of supply offered by cities remains crucial to the spatial strategies of service industries.'*

While data centres are increasingly seen to be central in driving the economy there is a growing awareness within the ICT industry of the importance of geography in data centre development. DataCenterKnowledge, a leading online source of news and analysis for the data centre industry, for example, has argued that *'Geography is always top of the list of considerations by companies when choosing data center location'* (DataCenterKnowledge 2012). This reflects the fact that *'geographical location can affect everything from the cost of electricity, to the probability of a natural disaster, to the availability of a skilled workforce*

to handle maintenance' (Datamation 2011). There is a growing volume of material has been published in the geographical literature on the geography of the Internet, (e.g. Donert 2000; Zook 2007: Zook and Graham 2007)), particularly within the US (e.g. Malecki 2002: Malecki 2012)), and on the geographies of cyberspace (e. g. Kitchin 1998) and virtual worlds (e. g. Taylor 1997). More specifically Malecki (2012) has suggested that *'the geography of the Internet is the geography of data centres.'* However while trade estimates suggest that the UK has some 7.5 million square metres of dedicated data centre and data communications space (DatacenterDynamics 2011) the locational distribution of data centres in the UK has received little attention from geographers. This may be the result of the recent growth in data centre development, the lack of any audited and readily accessible data concerning data centres and the secrecy with which some of the companies operating and developing data centres seek to shroud their activities. More generally it certainly seems to reflect the suggestion by Intellect, the UK's leading trade association in the technology industry, that *'there remains insufficient recognition and appreciation of data centres as an industry in the UK'* (Intellect 2012). With this in mind this paper outlines the origins and characteristics of data centres and offers an exploratory discussion of their locational dynamics and their changing geography within the UK. The paper is based on information drawn from the Internet, principally the data centre operators; local authority; property development and management company; and IT trade association websites and on personal communications with a small number of individuals within local authority planning departments and property development companies.

Data Centres: Characteristics and Origins

A data centre has typically been defined as *'a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business'* (TechTarget 2012). That said any consensus in precisely defining the term data centre is difficult not least in that *'the words data centre mean different things to different people'* (DatacenterDynamics 2012). While the global economy is increasingly seen to be dependent on data centres, information on the number of data centres and on data centre space is limited and defining data centre markets and market sizes is widely seen to be a major challenge (Applied Computer Research 2010). That said Emerson Network Power estimated that there are some 509,000 data centres worldwide, occupying some 26.5 million square metres of server space (DataCenterKnowledge 2011).

The emergence and rapid growth in the number of data centres reflects a number of developments in information and communication technologies. Initially these included the advent and increasingly widespread use of micro computers, the growing complexity of IT systems and the massive growth of client-server computing. Data centres essentially came of age in the dot.com boom around the turn of the millennium when large numbers of companies required rapid and constant Internet connectivity and dedicated data storage facilities. More recently the advent and growth of cloud computing and the explosion in the use and popularity of mobile computing and social media sites have not only further fuelled the need for data centres but have also placed more stringent demands on data storage which can be better met within such centres. Rath (2011), for example, suggests that the

definition of what constitutes a data centre has changed markedly over the last twenty five years which in turn reflects changes in size, sophistication, handling capacity and design.

The majority of the equipment within data centres is servers mounted on rack cabinets which are normally placed in single rows with aisles between them so that the staff has easy access to both the front and rear of the cabinets. Communications within data centres depend on sets of routers and switchers that facilitate communication between the servers and the outside world. Data centres certainly vary in size. In theory, for example, data centres can occupy a single room within a building, one or more floors of a building or an entire building and in the very large data centres shipping containers are packed with perhaps as many as a thousand servers. Communications within data centres depend on sets of routers and switchers that facilitate communication between the servers and the outside world. The vast majority of the initial data centres were housed in existing industrial and warehouse properties, that were retro-fitted to enable them to house the racks of servers, but such centres generally do not meet the sophisticated demands of modern users. More recently the focus has been on the development of new custom designed and purpose built centres. Although such centres were initially generally seen to have a long lead time for acquisition and construction in addition to that for fitting out, they are now favoured by many large companies because they can be specifically designed to meet standardised global blueprints which in turn offers significant time and cost savings. The Sentrum 4 data centre at Woking is located in a six hectare site with dedicated car parking on a trading estate and it offers 20,000 square metres of server space and a further 6,000 square metres of office and ancillary space. The Telehouse West data centre in London Docklands is a 19, 000 square metres, nine storey building, across five tenant floors each with its own dedicated server space, power supply and cooling facilities.

On the other hand four principal business models of data centres can be recognised. Firstly what might best be described as the corporate data centre which is located in-house and managed by the company's own staff and which is exclusively used by large companies or governments for the storage of their own data. Many companies and organisations certainly believe that owning and operating their own data centre makes sound economic and/or strategic sense. However in the face of rising costs and seemingly ever more sophisticated technological innovation, many companies have not been in a position to develop and manage their own facilities and they have increasingly come to regard outsourcing as a compelling and competitive alternative to operating and managing their own data centre. Here a distinction is often made between wholesale and retail data centres.

In the former property focused companies lease data centres to service the wholesale data management, storage and processing needs of large organisations, such as banks and financial service companies, large corporate customers, IT service companies, or government departments. The accommodation is usually let on a shell basis to be fitted out by the tenant with the landlord providing power only and leases typically last for at least ten years. In the latter the operating companies offer data storage, processing and management services to a large number of customers and varying amounts of space are let fully fitted with leases typically lasting between three and five years. Fourthly there are

carrier owned data centres which, as their name implies, are owned and operated by data carriers and connected to the network of that carrier. The users of these centres tend to be either carriers themselves or small companies who rent server space in the centre.

The physical environment of data centres is strictly regulated and air conditioning is used to control both the temperature and humidity. In order to achieve optimum performance average room temperature is typically maintained at 22^{o}C (±2) with a humidity level of 50% (± 10%) and centres also have sophisticated water and smoke detection and sprinkler systems. Powerful cooling systems are required to offset the heat produced by the servers and more energy is needed for cooling than for data storage and processing. That said a growing number of centres are using fans rather than air conditioning systems to keep servers cool. Many of the new purpose built data centres are housed in dust free environments and employees were specialised clothing to minimise dust and static. Data centres are major energy users and while smaller centres draw just a few kilo watts of power the larger centres will draw up to a hundred mega watts. Many data centres have power densities over a hundred times that of a normal office building. At the same time some data centre operators are looking to purchase power from cleaner and more sustainable sources, including wind, hydro and tidal power in an attempt to assuage growing environmental concerns. Security is a major operational concern. New measures are constantly being introduced to combat the threat of cyber crime, access by personnel is strictly controlled and data centres have video camera surveillance and security guard patrols.

Locational Dynamics and Changing Geographies

There is some general consensus within the industry that the UK represents one of the largest data centre markets in the world. In the June 2012 issue of its monthly Data Centre magazine GVA Connect (GVA Connect 2012a), for example, argued that *'the data centre sector has begun 2012 in bullish fashion'* and it ranked the UK as the second best country (with the US ranked first and Germany third) in which to locate data centres reporting that' *its high international internet bandwidth capacity and ease of doing business put it above all other European locations surveyed.'* However there is no independently audited register of data centres in the UK and E&T (2011) suggests that variations in physical size and data storage capacity mean that *'arriving at a headcount figure can only be an educated estimate.'* In 2011 E&T, for example, reported approximately 250 commercial data centres in addition to some 220 data centres across central government, some 600 in local government and the wider public sector and a further 88 with police authorities in the UK while a year later GVA Connect (2012b) estimated there to be 325 data centres within the UK while the Royal Institute of Chartered Surveyors (2012) put the figure at 1,450. More generally an *'Industry Census'*, carried out *by* DatacenterDynamics (2011), suggested that in 2011 there was some *'7.59 million square metres of dedicated data centre and data comms space'* within the UK.

The geography of data centres reflects a wide range of locational drivers and constraints though the vast majority of the early data centres were developed within companies' existing buildings and thus locational patterns often reflected existing corporate geographies. However a range of locational factors can be identified for new purpose built centres including access to large reliable power/electricity supplies; the availability and quality of telecommunications; both the environmental attractions and risks associated with specific locations; security; land, development and power costs; government financial incentives; the availability of suitable sites; and the ability to gain planning permission. Data centres use large amounts of power and they thus need to be connected to adequate electricity supplies and the developers may need to install dedicated substations, along with generators and coolers, to ensure the centres will have sufficient and uninterrupted power supply. Data centres also need access to high speed fibre cables, with large centres typically requiring some 100 Gigabits per second to meet customers' requirements, and this can be a constraint on locational options.

Initially data centres were concentrated within large cities. Within Europe, London, Paris, Frankfurt and Amsterdam have been widely recognised as the principal locations for data centres. Within the UK, for example, London has often been seen as the preferred location and this reflects connectivity, accessibility and community. London is the commercial capital of the UK and many corporate customers prefer to be close to the data centres that already handle their business. At the same time London is the only place where a large number of international fibre-optic cables terminate. This puts the city at a major advantage when it comes to carrier choice and latency (namely the amount of time it takes for a packet of data to get from one location to another). The city was also seen to have a reliable power supply. Many of London's data centres are within easy walking distance from underground stations or public transport, which means operators can get to their equipment quickly and easily to undertake installations, upgrades and repairs. At the same time being close to other data centres in London can offer operational and human resource benefits. There are opportunities, for example, to lease existing cables rather than to incur the expense of installing new ones, and the company's employees can share experiences with other professionals.

However new locations are now emerging. In the US, for example, while the early large data centres were in New York, Los Angeles and Chicago, a growing number of new centres are located in more isolated rural locations. The Facebook data centre in Oregon, one of a number the company operate worldwide in order to be able to deliver its services rapidly and reliably to its users around the world, for example, is built on a high plain above the small town of Prineville, which has a population of less than 10,000. Within the US such locations offer abundant low cost land, cheaper sources of power and a range of tax incentives. Similar trends are emerging in the UK and there are a number of data centres in central locations in major cities including Manchester, Edinburgh, Cardiff, Leeds and Bristol, on green field sites in many smaller towns and cities and in a growing number of rural locations. In 2011, for example, electricity pricing in central London was averaging £600 per kW per month while elsewhere in the UK corresponding prices ranged from £200 -£500. At the same time growing concerns about the availability of additional power supplies for new centres in the capital and worries about future flooding attendant on global warming and

the risk of terrorist attacks in London are important locational factors. While the geography of data centres may be changing, large city locations, which are near to customers and cable connections, will continue to be popular. Thus while one data centre company describes its London data centre as being in *'a prime location in the heart of London'* (Safehosts 2012a) it intriguingly advertises its Cheltenham data centre by suggesting to potential customers that they can reduce the risks, as outlined above, perceived in central London may '*prefer to host your servers in a location outside the M25 danger zone, our Cheltenham facility is perfect for you'* (Safehosts 2012b).

As outlined earlier data centres use large amounts of power both to run the servers and for cooling. Developers of proposed new centres are increasingly coming under pressure to demonstrate how they will reduce energy consumption and carbon emissions and mitigate the resulting environmental impact. On the one hand data centre operators have been looking to design computing and storage systems that are more and more power efficient. There is also growing interest in purchasing power from cleaner and more sustainable sources, including wind, hydro, geothermal and tidal power, in an attempt to assuage growing environmental pressures. On the other hand there is growing interest in siting new data centres in locations with cold and mild climates and on using fresh air for cooling. The developers of the Peelhouses data centre at Lockerbie in south west Scotland, for example, claimed that *'the cool climate enjoyed in Lockerbie, and amplified by the site's 215 metres of elevation, provides a perfect background for ambient air cooling throughout the data centre'* (Lockerbie Data Centres undated).More remotely the Verne Data Centre, near Keflavik on the south west tip of Iceland, the Green Mountain Centre north of Stavanger in Norway, and the Facebook data centre at Lulea in northern Sweden all harness sustainable power resources and utilise cold natural air to cool their servers. These trends add to the locational attractions of new centres in isolated rural locations and could potentially reduce development pressures within the UK.

At the local level gaining local authority planning permission has been a constraint the development of new data centres not least in that *'the town and country planning system has not caught up with the increasing g number of buildings which are being used as data centres'* (Data Management 2012) and here land use classification, energy demands, amenity and employment have been issues. Classifying a data centre for local authority planning applications has not always been straightforward in that data centres did not seem to fit easily into the existing use categories. In part this was because there was confusion about whether a data centre should be classed as an industrial use (B2), as business space (B!), as storage space (B8) or if should be considered *sui generis,* that is, as a use of its own. Some developers have tended to classify data centres to match development plan zoning on a case by case basis. However there is an emerging consensus around categorising data centres as B8 following a ruling by the inspector at a planning appeal for a data centre at Magna Park in Milton Keynes in 2009 (The Planning Inspectorate 2009). Here the Inspector noted that although data centres house computerised electronic equipment this does not mean that the focus of the operation is on the use of computers and that the use of electronic equipment no more makes that the primary purpose of the of the centre than the use of racks and rails is the primary purpose of a clothing warehouse.

Energy demands are a major issue and developers of proposed data centres are coming under pressure to demonstrate how they will reduce energy consumption and carbon emissions and mitigate the resulting environmental impact. Until relatively recently many local authorities tended to view the power needs of both the computing and cooling equipment as process loads and therefore outside of their sphere of control. However the Greater London Authority is increasingly taking a lead in designating data centre energy needs as being subject to planning and building control regulations. There are also a number of amenity issues. In order to guarantee uninterrupted power supplies, for example, developers need to install dedicated diesel generators. Here planning concerns have been raised about the noise associated with backup diesel power generators which would be used in the event of a power disruption. That said such events are relatively rare and generally short lived. More generally the careful design of landscape and the innovative design of building elevations can be important in helping to minimise the impact of the development on the visual amenity and to integrate the building into its immediate surroundings.

Planning concerns have also been expressed that data centres generate limited employment opportunities and thus should not be seen as a priority for local authorities which are often keen to report substantial employment generation when determining, and justifying, what can be controversial planning decisions. The construction phase of a large data centre may create up to 2,000 jobs but once operational such a centre will typically generate 100 permanent jobs. Critics often suggest that many of the jobs created by such centres are actually transfers of jobs from elsewhere and that the benefits to the local community are limited. Developers, however, argue that new data centres have a vital role to play both in retaining existing industries and jobs and in sustaining the local economy.

Conclusions

The storage and processing of data has become a major issue for many companies and organisations and data centres now play a vital role in both business and social life throughout the modern world. As digital data becomes ever more important to us all so data centres are becoming icons of the new economy and of our social lives. Within the UK data centres were initially concentrated in London but a range of new locations are now emerging. Writing over a decade ago Malecki (2002) argued that investment in the Internet facilities was concentrated *'in the world's largest cities'* and that this was *'reversing decades of suburbanization'*, that *'the evolving structure of the Internet is reinforcing old patterns of agglomeration '*but a decade later the same author (Malecki 2012) suggested that *'data centres tend to agglomerate and to disperse.'* More generally this would strike a chord with Alderson and Beckfield's (2012) suggestion that *'globalization is generating a new geography of centrality and marginality.'* The current evidence from the UK certainly seem to suggest that Malecki's (2002) initial judgement may, in part at least, have been premature and that developments at the international and national level would certainly seem to be consistent with his later judgement in that the initial locational dynamics of data centres are now changing. That said while the geography of data centres may be changing the need to design ever more sustainable centres, that increase energy efficiency and reduce carbon emissions, will surely remain constant.

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