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Title: Leading complexity: the evolution of a 'Tech City'

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Leading complexity: the evolution of a 'Tech City'

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Summary

This research is an integrated urban economics planning study that analyses the evolution of a creative digital cluster in inner East London. Its focus lies on trying to generate a better understanding of the complex actions and events that have led to its emergence and expansion in the last decade.

After discussing various conceptual understandings of how industry clusters develop over time the adaptive cycle model from panarchy theory is adopted as a lens to describe this cluster's evolution. The model is based on the assumption that clusters can be seen as complex adaptive systems with interconnected agents constantly adapting to changing environments.

In order to attempt to explain the cluster's evolution, a model based on complexity leadership theory is adopted. It focuses on the identification of different administrative, adaptive and enabling leadership strategies that help support system dynamics.

A qualitative case study approach is used to generate a descriptive narrative of the cluster's evolution. This narrative, developed through semi-structured interviews and secondary data, serves as the basis for analysis. Changes in specific adaptive dimensions are identified as well as key actions and events that have influenced the cluster's evolution.

The results of this study suggest that to date the cluster has evolved through two phases of the adaptive cycle model – reorganisation and exploitation. The level of accumulated capital and connectedness has grown during this time and the cluster appears to be relatively resilient to changing dynamics.

Analysis also indicates that administrative leadership appears to have been more influential in developing the cluster during the exploitation phase than the reorganisation phase. Enabling leadership strategies have been important in both phases but they appear to have been more purposeful during the exploitation phase. The cluster has generated an increasing amount of adaptive leadership outcomes as it has evolved. A key enabling leadership action has been identified as transitioning the cluster between reorganisation and exploitation phases.

The study's findings would infer that there is a role for more administrative actions within cluster-based policy. However, these actions should be taken considering respect of the need for a certain amount of autonomy within the cluster to allow it to adapt to evolving circumstances.

Due to these two complexity theory based models still being relatively undeveloped, it is recommended that further application of the models to other cases be conducted in order to compare methods and findings.

Keywords

Creative Clusters; Complex Adaptive Systems; Adaptive Cycles; Complexity Leadership; Evolutionary Economics.

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Abbreviations

CAS	Complex Adaptive System
CGS	City Growth Strategies
CLT	Complexity Leadership Theory
GLA	Greater London Authority
IHS	Institute for Housing and Urban Development
TCIO	Tech City Investment Organisation
TSB	Technology Strategy Board
VC	Venture Capital
UKTI	United Kingdom Trade and Investment

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Chapter 1: Introduction

This chapter provides an overview of the research topic and explains the rationale for conducting the research and choosing this specific case. It provides background information important to understanding the case and describes the research problem, objectives and questions. It concludes with an explanation of the research scope and limitations.

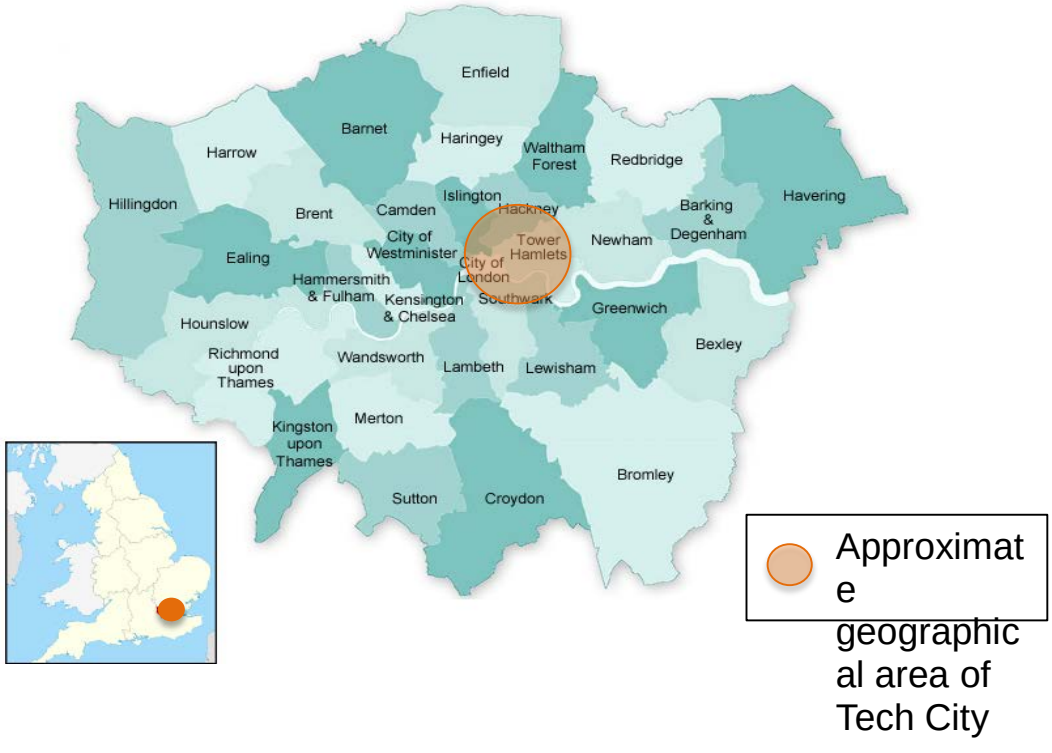
1.1 Background

Ever since Porter's seminal text the *Competitive Advantage of Nations* published in 1990, the idea of industry clusters as a mechanism for economic growth and innovation has intrigued policymakers and businesspeople alike. However, the analysis of clusters has proved challenging as they involve complex webs of interlinked firms and institutions interacting in dynamic ways. Their evolutionary paths are often uncertain with just as many suffering an early death as those going on to survive for decades.

In the wake of the global financial crisis in Britain, governments and the private sector were looking to identify new sources of growth and innovation that could provide a path out of the recession. A concentration of small creative technology firms in inner East London was identified as having the potential to grow quite rapidly and perhaps establish the capital as a hub for the new digital economy. This cluster had seemingly grown organically over the previous 5-10 years and had proved remarkably resilient to the downturn that had affected most other industries in the UK.

It has experienced considerable growth in recent times, moving on from a group of small companies occupying shared working space to now being home to multinational corporations and numerous large start-up incubators. In 2008, there were 15 technology start-ups identified as operating in the vicinity of Old Street in the district of Shoreditch in East London. In 2013 there were over 1,300 technology related businesses in the broader cluster area (HM Government, 2012). See Figure 1 for the approximate location.

Figure 1 - Location of Tech City cluster in London, UK



Source: Graphatlas.com, 2014

This research focuses on the evolution of this cluster that is commonly referred to now as Tech City. Of particular interest to this study is the analysis of actions and events that allowed the cluster to evolve and adapt to changing dynamics. Systems that are characterised by evolutionary adaptation without a central controlling mechanism are often described as complex adaptive systems or CAS (Holland, 1992). The East London cluster appears to resemble a CAS with much of its growth attributed to the self-organising activities of local entrepreneurs with a small enabling role played by government (Campbell, 2014).

This research will focus on what is described as complexity leadership which is how the interactions between various agents within a system lead to innovative and adaptive outcomes (Lichtenstein et al., 2006). Outcomes such as how the adhoc sharing of workspace led to informal networking events and the coining of an initial cluster name (Cowan, 2013). How a meeting between an entrepreneur and a Prime Minister's policy advisor led to an increase in capital and an expansion of geography (Wood, 2013). How a partnership between a tech giant and business incubators has attracted international attention and injected creative tension (I4).

1.2 Problem Statement

Despite the depth of empirical analysis of industry clusters in the last two decades, it has been noted that there is still no accepted theory of cluster evolution (Sunley and Martin, 2011). The development of clusters across the world has proved to be as varying and complex as the interactions within them.

Considering the weight of resources and policy effort put into growing and maintaining industry clusters, a better understanding of what influences their development is crucial. Most governments are still at odds over whether to be directive or hands-off when dealing with new or existing clusters. Failed cluster policy comes at a huge cost to administrations and also sometimes to the relative long-term competitive advantage of a region or city.

Tech City holds the commercial and community interests of a vast amount of people in East London and the UK. Millions of pounds have been invested in tech start-ups and the urban landscape has changed considerably in the last five years as a result of the cluster's growth. Analysing the evolution of the cluster and the complex strategies that have enabled its growth is crucial for understanding the potential future of the cluster and also the mechanisms for enabling other clusters in the country to grow.

1.3 Research Objectives

The main objective of the research is to examine what complex leadership strategies enabled the evolution of the creative digital cluster in inner East London. The study will also explore the applicability of an adaptive cycle as a descriptive representation of the cluster's evolution. The analysis aims to identify actions and events within the cluster that influenced the development of the cluster through different phases of this adaptive cycle.

The findings can be used to establish principles for effective cluster management that can inform future cluster policy. The research can also serve as an additional insight into the suitability of adapting complexity theory concepts to the study of the evolution of clusters or similar organisational networks.

1.4 Research Question(s)

The main question that this research would like to answer is:

What role did different complexity leadership functions play in the development of East London's creative digital cluster?

Specifically, this research seeks to find answers to the following sub-questions:

- *How closely does the cluster's development reflect the early phases of an adaptive cycle? How have the adaptive dimensions of accumulated capital, connectedness and resilience changed over time?*
- *What strategies within administrative, adaptive and enabling leadership functions have been important in the development of the cluster to date?*
- *Which of these leadership functions have been most influential at different phases of the cluster's evolution?*

1.5 Significance of the Study

From a theoretical standpoint, this research provides another perspective on the application of an adaptive cycle model to a social system. In particular it offers an evaluation of the model to cluster developments. Recent literature (Sunley and Martin, 2011) has highlighted the weaknesses in traditional cluster life cycle models for explaining the variety of pathways that clusters can take. This thesis will provide some input into whether the adaptive cycle is a better tool for describing cluster evolution.

In addition, this research seeks to explore the constructive forces that shape clusters in a way that is less utilised in most cluster research. Interactions between agents in a cluster are said to be crucial in understanding the success or failure of a cluster (Sölvell, 2008) and this thesis uses the concept of complexity leadership theory to analyse these interactions. This theory has been adopted for studying other social systems but is still a developing field of study. Therefore, this research offers an additional case that can inform the growing body of work focussed on leadership within complex adaptive systems.

Cluster policies and strategies are popular tools for public and private sector leaders who are attempting to build the competitiveness of their jurisdiction or firm. This research's findings may help to inform current cluster initiatives or future cluster policy. It may provide a different perspective on how complexity within industry clusters, especially creative ones, can be managed and utilised to improve the adaptability and innovation of the cluster.

1.6 Scope and Limitations

This study primarily relies on a qualitative research approach, which leaves the analysis of data open to subjective interpretations. Secondary data is utilised to improve internal validity.

The use of a single case study to analyse complexity concepts limits the generalisation of findings. The use of theoretical frameworks to guide analysis provides findings that are analytically generalisable to other cases.

The brevity of time allowed for fieldwork and the researcher's initial unfamiliarity with the cluster being analysed potentially affects the quality of data choices and interpretive analysis. Background research and discussions with acquaintances in the industry helped support purposive sampling and understanding of cluster dynamics.

Chapter 2: Literature review

This chapter will explore the theoretical concepts that guide the research and analysis conducted as part of the thesis. It will start by discussing the basic concepts of traditional cluster theory and whether it is an appropriate mechanism to explain the spatial orientation of firms within creative industries. Traditional evolutionary economic theories of cluster development will also be described, as well as more recent perspectives that approach clusters as complex adaptive systems. Following this it will look at the role of leadership as a dynamic mechanism to enable the emergence of complex systems such as clusters. The chapter will conclude with an explanation of the conceptual framework adopted for this research.

2.1 Industry clusters

The concept of industry clusters and their importance to regional and national competitiveness came to prominence in the early 1990s. Michael Porter was one of the first, and arguably still the most influential, proponents of the competitive advantage gained by similar firms or sub-industries locating in close proximity to each other. He argues that inter-firm cooperation and competition that breeds innovation and productivity is magnified with greater geographic concentration (Porter, 1990).

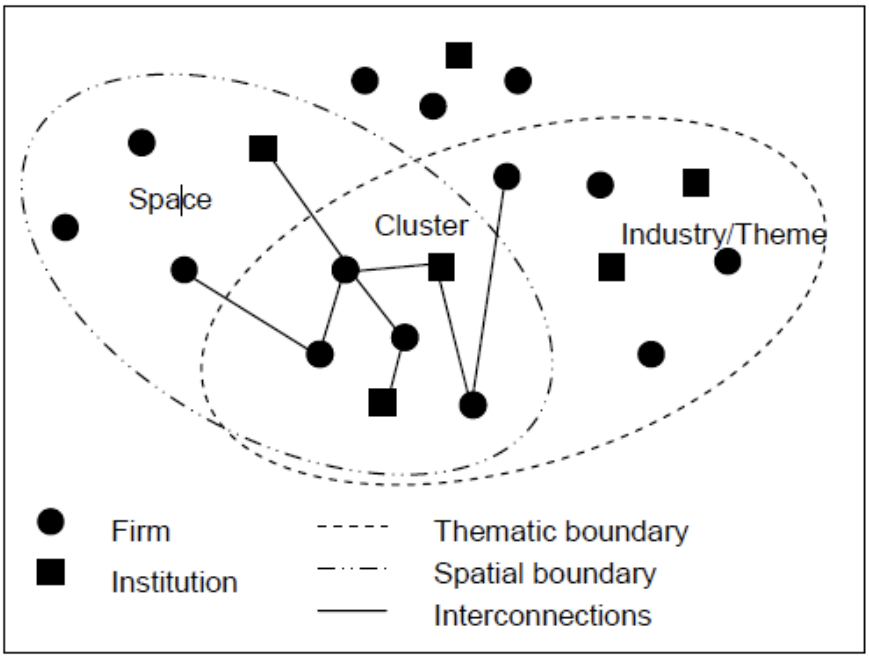
Porter's work built on much earlier ideas of industrial localisation, most notably those of Alfred Marshall. In his book *Principle of Economics*, published one hundred years before Porter's cluster concept, Marshall details the advantages generated by skilled people in similar trades co-locating. These include: the development and uptake of new ideas; the shared use of specialised expensive machinery; and greater efficiency in supply and demand of skilled labour (Marshall, 1890). These benefits are now commonly associated with the concept of economies of agglomeration, which refers to the reduction in transaction costs by firms that cluster within specific nodes in an urban area (Hoover, 1948).

Numerous studies into spatial concentration of firms and industries were conducted before and after Porter's early work into clusters but none have been as influential. His terminology has made its way into research by economic geographers that previously coined other descriptive terms and his theories regarding the role of government have informed cluster development policies across the globe (Martin and Sunley, 2003). Porter defines a cluster as:

> "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities."(Porter, 1998a p.4)

There is some debate over the vagueness of Porter's definition of a cluster, especially the lack of clear limits to the geography or type of institutions that designate a specialised concentration (Martin and Sunley, 2003). However, there is general acceptance of the key elements of his definition - that a cluster consists of firms and institutions; that there are general industrial categorisation and spatial boundaries to the cluster (if a bit vague); and that there are connections between agents in the cluster (Menzel and Fornahl, 2007). See Figure 2 for a diagrammatic representation of these elements.

Figure 2 - Key elements of a cluster



Source: Menzel and Fornahl, 2007

The importance of clusters to the development and competitiveness of urban regions has been well documented. Research has shown that firms within clusters experience higher rates of productivity and innovation than those outside clusters (Klepper, 2010). They have also been suggested as mechanisms for the regeneration of inner city areas (Porter, 1995).

2.2 Creative industry clusters

In recent decades, much discussion has developed around the rise of a new class of industries and firms that don't fit traditional industry categorisation. The term creative industries has been coined to refer to "those activities which have their origin in individual creativity, skill and which have the potential for wealth and job creation through the generation and exploitation of intellectual property" (DCMS, 1998 cited by Berg and Hassink, 2013, p.5). They tend to represent the intersection between commercial and cultural enterprise and generally include industries such as television, film, performing arts, advertising, design, software development and digital media (Turok, 2003).

Creative industries have also displayed a tendency to cluster to achieve localisation and urbanisation economies (Lazzeretti et al., 2009). Even Richard Florida, perhaps the most well known proponent of the economic development benefits generated by the so-called 'creative class', identifies the role of spatial proximity. He describes how despite the increase in technological capabilities that have improved telecommunications and transport systems, high-tech knowledge based industries continue to concentrate in specific locations (Florida, 2003).

A question arises as to why digital based creative industries cluster even though they are seen to be not as reliant on physical proximity to suppliers or consumers as traditional industrial producers. There is evidence to suggest that knowledge intensive firms, which generally make up a large proportion of creative industries, stand to benefit less from agglomeration economies (Boschma and Frenken, 2011). It has, however, been shown that creative firms and industries still gain advantages from the cooperation and competition produced by the vertical and horizontal linkages that clusters provide (van Heur, 2009).

Another proposed answer is that innovative activity relies heavily on tacit knowledge. This is possibly even more so now due to the ubiquitous nature of more tradable knowledge, which

makes it harder to gain a competitive advantage (Maskell, 2001). Tacit knowledge is said to be relatively 'spatially sticky' as it relies on interactions between different agents who share a common social context (Gertler, 2003). Maskell (2001) suggest that the linkages between various firms within clusters serve to enhance processes of knowledge creation, which is crucial for creative industries.

Creative clusters are also assumed to be predominantly located in urban areas. Cities provide the necessary interactive environment for new ideas to be shared, discussed, adapted and transformed into innovative products and processes (Turok, 2003)

The growing recognition of creative clusters has emphasised the importance of innovation and knowledge spillovers as driving factors of industry concentration as well as the more traditional efficiency gains (Sölvell, 2009). Interaction between firms and institutions is said to be the basis of innovations in clusters (Sölvell, 2009). This is equally relevant to creative industries where new products, processes and businesses are often born out of discussions between different agents.

2.3 Cluster development and evolution

While there is a general acceptance of the concept of clustering of firms and associated organisations, there are a number of theories to describe how clusters develop and evolve over time.

2.3.1 Traditional cluster theory

Initial approaches to the study of clusters have used traditional business economic methods to explain how they develop and evolve. Research tended to focus on the exogenous forces that influence firm behaviour and patterns of spatial distribution (He et al., 2011). Many studies looked at the physical endowments or strategic location of regions that influenced industrial or trading companies to co-locate (Ketels, 2003). However, location factors alone have not been conclusive in explaining the development or non-development of clusters in similar areas (Pouder and St. John, 1996).

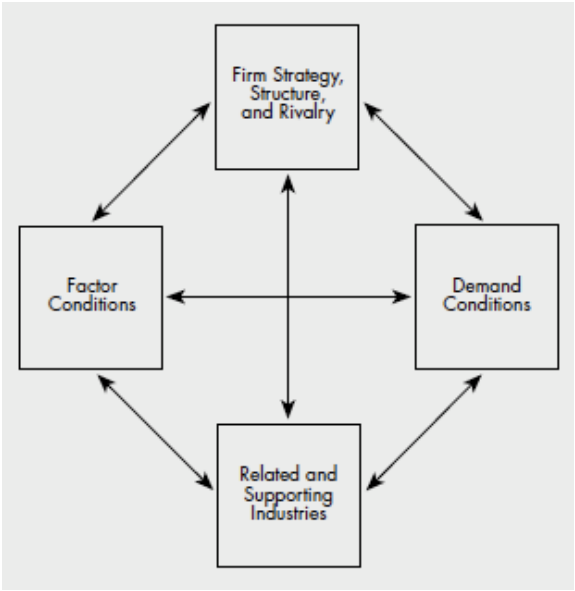
Other research has looked at important companies or education institutions that served as the launching pad for spin-off companies or as attractors to complementary suppliers (Ketels and Memedovic, 2008). There is also considerable weight given to the role of chance in the success of highly competitive clusters (Pouder and St. John, 1996).

Porter describes how the beginnings of a cluster often relate back to the presence of factors within his competitive diamond model (

Figure 3). He illustrates how clusters have formed in locations with strategic resources, strong specialised local demand, established related clusters, or particularly dynamic companies (Porter, 1998b). The diamond model has been used by many to not only explain the characteristics of a cluster, but also to inform strategies aimed at developing established clusters further (Martin and Sunley, 2003). The general idea is that by enacting policies that improve necessary resources (infrastructure, skilled labour) and create a local environment that facilitates competition and new business start-ups, clusters will prosper (Porter, 1998a).

Once the beginning of a cluster is established, it is assumed that agglomeration economies will attract new firms and institutions to the area reinforcing the initial development (Pouder and St. John, 1996). The development of a cluster overtime is said to be heavily dependent on its ability to maintain competitive rivalry which breeds innovation and its ability to adapt to changing technology and market demand (Porter, 1998b).

Figure 3 - Porter's Diamond



Source: Porter, 1990

There is, however, an observation amongst researchers that cluster theory offers a lot of insight into how clusters function but commentary on the life cycle of clusters, including how they emerge and evolve over time, is incomplete (Maskell and Kebir, 2006; Menzel and Fornahl, 2007).

2.3.2 Evolutionary economic geography

In recent decades, the developing field of evolutionary economic geography has provided another perspective to analyse the way clusters develop and evolve. Research in this area generally adapts concepts from the broader field of evolutionary economics to inform new economic geography theories (Martin and Sunley, 2006).

Evolutionary economics is a branch of economics that adopts general and often biological, notions of evolution to study how economic variables or systems change over time (Nelson, 1995). Economic geography developed from the understanding that mechanisms of economic development are spatially distinct and geographically determined (Martin, 1999). Evolutionary economic geography therefore attempts to explain the spatial evolution of economic agents from the elementary processes and behaviours of organisations, typically firms (Boschma and Frenken, 2011).

When applied to clusters, evolutionary economic theories have been used to explain why clusters emerge in specific areas and endure despite the possible non-existence of strong localisation economies (Boschma and Frenken, 2011). In these cases, they are said to evolve via spin-offs from parents companies and a survival of the fittest mentality that sees the more successful spin-offs generate new spin-offs themselves (Boschma and Frenken, 2011). A range of evolutionary economic concepts has been adopted to explain the spatial formation of firms or industries. Table 1 describes some of the most common concepts.

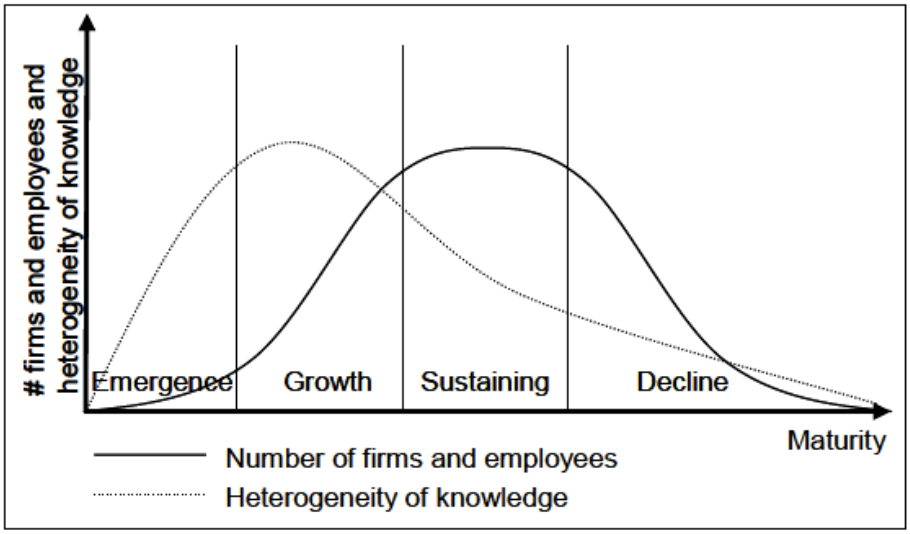
Table 1 - Evolutionary economics concepts applied to economic geography

Evolutionary economics concept	Application to economic geography and clusters
Routines	Firm level organisational skills are developed over time via experience and tacit knowledge sharing which displays elements of spatial concentration.
Path Dependency	The future direction of firms or clusters is heavily dependent on the historical context in which they are located.
Lock-In	Firms become locked into specific pathways because of their reliance on given technology or resources.
Increasing Returns	Positive feedback effects from agglomeration economies reinforce the development of clusters.
Chance	Firm decisions to locate in certain areas may be irrational; clusters may develop because of unforeseen chance events.
Selection	Firms with enough information can select locations based on favourable conditions.
Path creation	Some firms, industries and clusters have demonstrated abilities to generate new futures and break free of their historical roots.
Co-evolution	The evolution of firms and industries in a given area is supported by the mutual influence of evolving technology, markets, policies and institutions.
Human agency	Path dependency and/or creation can be influenced by the actions of actors within firms or clusters.
Related variety	Concentration of different but related industries leads to greater economic growth.

Source: Boschma and Lambooy, 1999; Martin and Sunley, 2006; Boschma and Frenken, 2006

The adaption of evolutionary economics to cluster development has also given rise to the idea of a cluster 'life cycle'. This concept has built on the adaption of life cycles in other areas of economics including for products, firms, industries and technologies (Martin and Sunley, 2011). It is suggested that clusters go through a process of emergence, growth, maturity and decline represented by an increase, maximisation and then decrease in the number of firms and employees within the cluster (Menzhel and Fornahl, 2007) (See Figure 5). This process is dependent on the level of heterogeneity between firms in the cluster. During the emergence of the cluster, diversity and innovation is high but as the cluster grows it starts to specialise and a path dependency (technology or knowledge process lock-in) is established which may see its diversity and ability to adapt decline. However, if a cluster manages to maintain and foster its diversity, it may be able to avoid decline and sustain itself (Menzhel and Fornahl, 2007; Martin and Sunley, 2011).

Figure 4 - Life Cycle of Clusters



Source: Menzhel and Fornahl, 2007

It has also been argued that agglomeration brings costs as well as benefits to clusters. There is evidence to suggest as a cluster reaches maturity costs from skilled labour and local suppliers have increased to the point where they negatively impact on firms within the cluster (Potter and Watts, 2010). Firms may leave the cluster or outsource operations to locations geographically distant from the cluster as technological improvements allow for the easier transfer of production or knowledge.

While the life cycle has proved a useful tool for studying the evolution of some clusters, it has been criticised for its simplicity and lack of usefulness in explaining the diversity of paths that real clusters follow (Sunley and Martin, 2011; Belussi and Sedita, 2009).

2.3.3 Complexity economics

Complexity economics is another developing field in economic theory that has crossover conceptual links to evolutionary economics and offers a new perspective on clusters and their development. It represents a new way of looking at the economy, where disequilibrium is the norm and there is a constant process of development due to the various responses of economic agents, not necessarily rational, to situations they helped to create (Arthur, 2013). It also differs from traditional economics by combining micro and macroeconomics to explain how macro level order or structures can emerge and evolve from micro level interactions (Beinhocker, 2006).

The name complexity economics stems from the incorporation of a broader theme of complexity thinking into economic theory. Complexity thinking has been successfully incorporated into the physical and natural sciences to analyse the dynamic non-deterministic nature of systems operating ‘far from equilibrium’ (Prigogine, 1987, p.97). This has eventually led to the established field of complexity theory, which is actually an umbrella term to describe a set of theories that look at open systems of complex parts and the interchange of substance and information within and without them (Portugali, 2012).

The term complex adaptive systems (CAS) has been coined to describe systems that have an evolving structure of interconnected components that adapt to changes in their environment, seemingly without any central controlling agent (Holland, 1992; Lansing 2003). CAS are characterised by lack of stability, constant evolution and emergence of new properties via self-

organisation (Portugali, 2012; Prigogine, 1987; Pavard and Dugdale, 2006). (See Table 2 for an explanation of some of the key characteristics of CAS)

Table 2 - Characteristics of complex adaptive systems

Characteristics	Description
Non-linearity	The structure and output of the system is not directly proportional to its components.
Non-determinism	Due to non-linear dynamics of the system it is not possible to predict the future behaviour or path of the system.
Emergence	Complex macro-level patterns or structures emerge within systems out of the behaviours and interactions of its components.
Self-organisation	Systems display a dynamic ability to develop and maintain structure without an external controlling mechanism.
Co-evolution	Systems and system components change and adapt as their environment changes, but this adaption cause changes to their environment which in turn cause them to change again.
Dissipative forces	Most systems are in constant interaction with their environments with which they exchange energy that supports the dynamism and adaptability of the system.
Autopoietic forces	Internal processes and mechanism enable the system to maintain its structure and reproduce its components.
Edge of Chaos	Systems have a balance of autopoietic and dissipative forces that enable it to maintain a sense of structure and still be adaptable to external changes. They therefore operate not in equilibrium or in chaos but on the 'edge of chaos'.
Limited functional decomposability	The system's dynamic structure makes it difficult to break it into structural components for analysis.
Distributed connectivity	Functional relationships are distributed across the system at different scales.

Source: Martin and Sunley, 2007; Pavard and Dugdale, 2006; De Wolf and Holvoet, 2005; Axelrod and Cohen, 1999.

Due to complexity economics being a relative new field of study, there is some debate over the application of notions from biological and physical sciences to the study of economic systems (Beinhocker, 2006; Martin and Sunley, 2007). There has also been some critique that complexity economics has not sufficiently provided enough discussion of spatial economic patterns to supplement existing economic geography theory (Martin and Sunley, 2007). However, key complexity concepts are apparent within certain literature. Krugman's new economic geography includes references to the self-organisation within economic systems and the feedback and spillovers that cause spatial patterns to emerge (Krugman, 1998). There has also been discussion of the self-organising processes that cause industry clusters to evolve (Brenner, 2001). Some have also suggested that space is crucial to the understanding of complex systems due to the inherent qualities of a location that influences the interactions between a system's components (O'Sullivan et al., 2006; Thrift 1999).

2.4 Industry clusters as complex adaptive systems

When looking at the structural composition of industry clusters and how they evolve, it has been argued that they display some resemblance to CAS (Martin and Sunley, 2011). Clusters contain components (firms, institutions) that interact with each other (complementary and competitive relationships) and establish macro-level patterns (spatial distribution and production processes) over time, seemingly independent of external control. Clusters have been shown to demonstrate characteristics of emergence, self-organisation and multiple path dependencies (Belussi and Sedita, 2009; Brenner, 2001; Martin and Sunley, 2011; He et al, 2011).

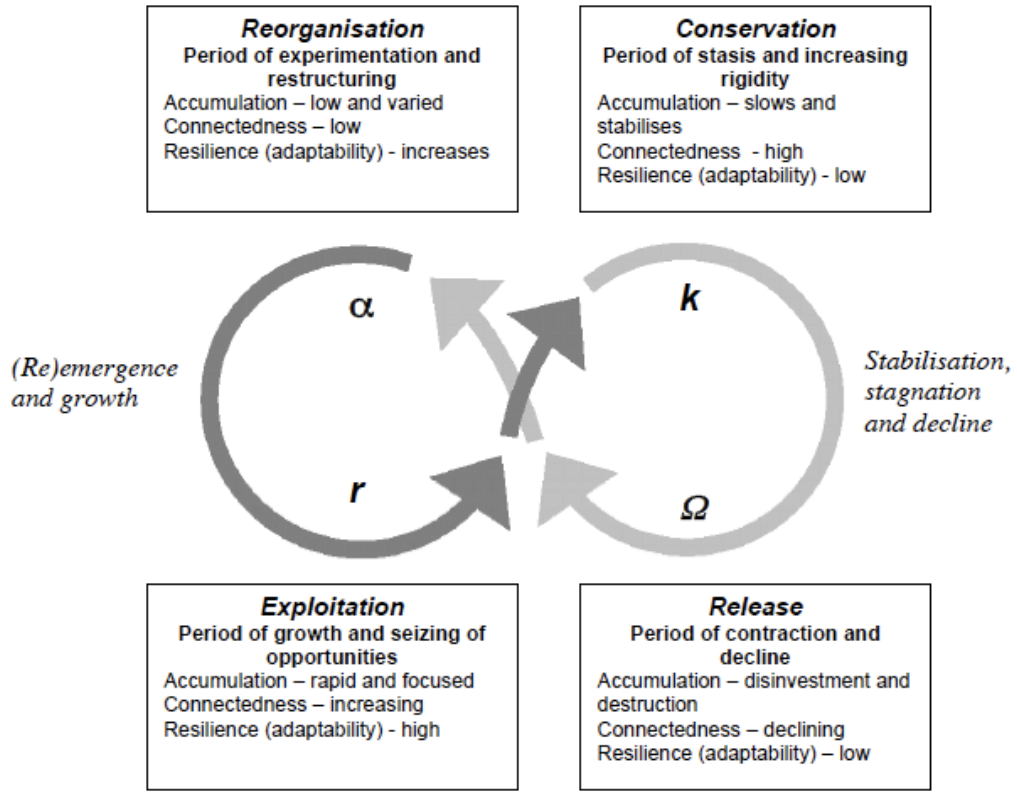
This chapter has previously discussed how traditional cluster theory focuses mainly on locational factors or exogenous processes that cause firms to concentrate in certain areas (Pouder, 1996; Porter, 1998b). However, these approaches say little of the internal socio-institutional processes between firms (and other agents) that are assumingly so important (Martin and Sunley, 2003). There is growing research into the application of complexity theory to the study of how socio-economic organisations, networks and clusters emerge (Chiles et al., 2004; Lindsey, 2005). Co-evolutionary capabilities of clusters and their capacity to exchange knowledge with and adopt new knowledge from their environments have proved appropriate areas of study when looking at the successfulness of clusters overtime (Lindsey, 2005).

Taking the view that clusters can be seen as CAS allows a new perspective on analysing how clusters evolve. The non-linearity dynamics of these systems explains why clusters display multiple pathways as opposed to the standard stages described within the traditional cluster life cycle model (Lindsey, 2005; Belussi and Sedita, 2009). Martin and Sunley (2011) have adopted the conceptual elements of an adaptive cycle model to overcome the life cycle's limitations, as it accounts for a greater range of possibilities found in cluster evolution.

An adaptive cycle model was originally developed by Holling (1986) to study the dynamic evolution of ecosystems. The model forms an integral component of Holling and Gunderson's (2002) theory of 'panarchy' that seeks to explain the role of change in complex economic, ecological and social systems. The model has four stages - exploitation (a period of rapid growth of the system – *r*), conservation (a period of stability - K), release (a period of decline brought about by an external shock - Ω), and reorganisation (a period of recombination of resources or restructuring - α). The transition from *r* to K is said to be more gradual, whereas the transition from Ω to α is said to happen rapidly leading to renewal of the system (Holling and Gunderson, 2002).

Each stage of the adaptive cycle is suggested to have varying levels of three different dimensions: accumulated resources, internal connectedness and resilience (Holling and Gunderson, 2002). In an economic system, resources would refer to capital (human, physical, knowledge), connectedness would refer to traded and untraded interdependencies, and resilience would refer to creative and adaptive responses to change (entrepreneurialism, innovation) (Simmie and Martin, 2010). A common diagrammatic representation of the cycle can be seen in Figure 6.

Figure 5 - Adaptive cycle

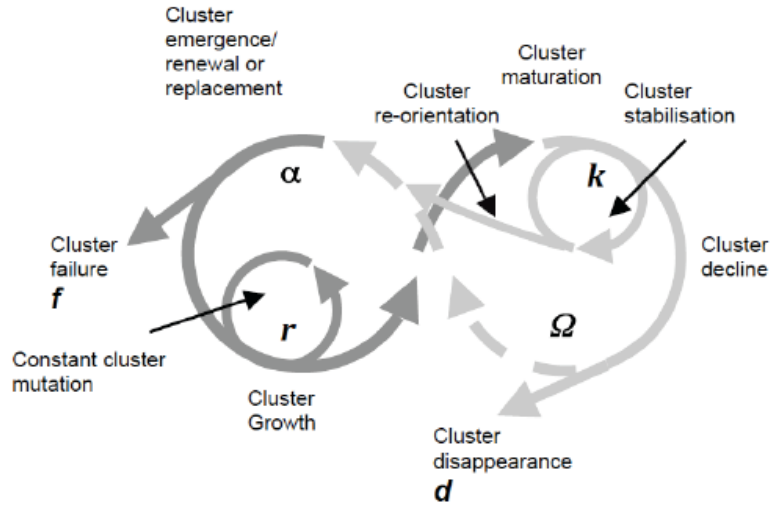


Source: Martin and Sunley, 2011

Martin and Sunley (2011) use the model to analyse the evolution of clusters, particularly looking at the accumulation of resources, connectedness and resilience of clusters within the different stages of the cycle. They postulate that the conservation stage may differ depending on flexibility of the cluster and that there are three pathways that can develop during the release stage of the cycle, the most unpredictable stage. Firstly, firms may adapt to external changes and enter a new release stage; secondly, a new cluster may form out of the leftover resources of the previous; and thirdly, the cluster and associated industries may just disappear.

Martin and Sunley (2011) go on to modify the adaptive cycle to reflect what they believe are its limitations in incorporating endogenous processes within the cluster that may generate even more possible pathways. These include the ones mentioned previously (labelled 'cluster full adaptive cycle', 'cluster re-orientation', 'cluster disappearance') and also where a cluster constantly adapts to changes in its environment ('constant cluster mutation), where a developing cluster fails to launch ('cluster failure') and where a cluster reaches maturity and survives but in a somewhat limited capacity ('cluster stabilisation'). These paths are represented in Figure 7.

Figure 6 - Modified adaptive cycle



Source: Martin and Sunley, 2011

The authors acknowledge that looking at cluster evolution from a complexity lens is in its early stages. However, they highlight that the model does acknowledge the importance of adaptability to a system's future and that a cluster's life is not necessarily predetermined to eventually decline (Martin and Sunley, 2011).

2.5 Cluster construction

Two types of forces have been recognised as shaping a clusters development – evolutionary and constructive (Sölvell, 2009). The first refers to environmental circumstances and general business activities of cluster agents and has largely been detailed in previous sections. The second refers to specific actions taken by agents within the cluster to manipulate its evolutionary path. This section covers constructive forces in more detail.

2.5.1 Cluster policies and initiatives

The increasing acceptance of industry clusters' contribution to firm and regional competitiveness has driven political, civic and business leaders to implement policies and strategies aimed at creating or growing clusters (Sölvell, 2009).

Strategic cluster policies and programs have been implemented at national and regional levels by governments across Europe. They usually work to improve the general business environment, attract FDI, support exports and provide resources that enable new technology adaptation within a cluster (Sölvell, 2009).

A specific type of strategy that involves the collective and coordinated efforts of multiple agents to shape a cluster's growth is the 'cluster initiative' (Sölvell et al., 2003). It often involves a partnership model between the public sector, the private sector, research institutions and civil society who work towards common goals such as increasing innovation and growing business and employment opportunities. A 2003 global survey highlighted the shared role industry and government play in establishing and resourcing cluster initiatives (Sölvell et al., 2003). However, firms were the most dominant player in establishing the structure and governance mechanisms of the initiative.

The success of cluster initiatives in maintaining the ongoing competitiveness of the cluster has generally been evaluated in terms of certain enabling factors. Sölvell (2009) highlighted the

importance of an adequately resourced initiative, a knowledgeable facilitator, a shared vision and a membership that is not limited in scope.

Most research related to cluster construction activities focus on matching characteristics of cluster policies or initiatives to quantitative measures of success. They do not provide much explanation of specific actions or interactions between actors that shaped the development and implementation of these initiatives. Commenting on the evaluation of clusters in Scotland, Sölvell (2009) states how "interactions in clusters are key in understanding the success of a cluster and so must also be included in the analysis" (p.100). Therefore, applying theoretical models for analysing interactions to clusters is appropriate.

2.5.2 Complexity leadership theory

A new approach to studying interactions between agents within organisational systems from a leadership perspective may offer a new perspective on analysing cluster constructive forces. The term complexity leadership has been used to describe leadership as not something lying wholly within individuals but in the interactive dynamics between heterogeneous agents that gives rise to adaptive results (Lichtenstein et al., 2006). It also utilises CAS as the main unit of analysis, which in this theory are described as networks of interconnected, interdependent agents who via working towards common goals form dynamic cooperative bonds (Uhl-Bien et al., 2007).

Complexity leadership theory is specifically targeted at addressing limitations with traditional 'top-down' leadership models that are not appropriate for the modern knowledge based economy (Uhl-Bien et al., 2007). Traditional hierarchical leadership is said to stifle the human and social capital that coevolves from strong employee networks (McKelvey and Lichtenstein, 2007). Additionally, similar to complexity economics, it challenges the view that organisations or systems are predictable and looks at what is the role of a leader if outcomes cannot be controlled (Plowman et al., 2007).

Leadership itself is considered to be an "emergent interactive dynamic" (Uhl-Bien et al., 2007 p.299) that leads to innovative outcomes and greater adaptive capacity. Leadership actions can emerge at different levels in different networks within the system (Nooteboom and Termeer, 2013). Uhl-Bien et al. (2007) have proposed that these actions can be categorised into three different functions of leadership that are necessary to draw out the dynamic potential of complex adaptive systems – administrative, adaptive and enabling.

Administrative leadership refers to the more recognisable role of managers in formalised positions who co-ordinate activities within organisations or networks. Administrative leadership actions include strategic planning, vision building, goal setting, and resource management (Uhl-Bien et al. 2007)

Adaptive leadership is the process of change that emerges from interactions between agents and groups who have different preferences - a so-called 'clash of ideas'. It involves the generation of new innovative processes and models that enables organisations to adapt to changing circumstances (Uhl-Bien et al. 2007).

Enabling leadership involves creating an enabling environment for adaptive leadership to develop and managing the entanglement between administrative and adaptive leadership. It does this by fostering interaction and interdependency and creating tension to stimulate networks within the system (Uhl-Bien et al., 2007).

The role of leaders as enablers is seen as particularly important to the emergent self-organisation found in CAS. It aids the development of organisational identity, which is shared by agents within the system and guides their actions in the absence of external control (Schneider and Somers, 2006). Enablers may not have formal authority but can act as 'tags',

people who have great influence within the community or system and aid the diffusion of ideas and social behaviours throughout the system (Marion and Uhl-Bien, 2001; Schneider and Somers, 2006).

2.6 Application of complexity theories to studying cluster evolution

The continuing fascination of policy advisors with cluster promotion and the acceptance that cluster success is dependent on more than just external environment factors has driven new cluster analysis methods. Clusters have begun to be considered in terms of the complexity that lies between components of the system as a whole and this complexity has been used a unit of analysis and to better inform cluster policy (Smith and Brown, 2009).

Cluster research that incorporates notions of complexity theory include He et al. (2011) who analyses the self-organisation of two ICT clusters in China, adopting the notion that industry clusters approximate CAS. Lindsay (2005) has applied the concepts of co-evolution and self-organisation to analyse the dynamics and development of a cluster in New Zealand. Smith and Brown (2009) have applied systems thinking to the study of cluster dynamics within Scottish industry clusters to analyse how they evolve over time.

Complexity leadership concepts have been applied to the study of the emergence and evolution of different organisational systems. Lichtenstein and Plowman (2009) have analysed the role of different leadership behaviours in enabling the complexity theory notion of 'emergence' within commercial firms, an organisational collective (similar to a cluster) and a church. Jungwirth and Ruckdäschel (2013) have adapted complexity leadership concepts to analyse the leadership behaviours of cluster managers and their effectiveness in managing cluster success. Nooteboom and Termeer (2013) have developed a framework that utilises Uhl-Bien and Marion's (2009) complexity leadership theory to analyse the development of a horticulture logistics cluster and an urban redevelopment area in the Netherlands.

This thesis aims to build on this research by using complexity leadership theory to analyse the evolution of a creative digital cluster.

2.7 Conceptual Framework

The framework adopted for this thesis relies heavily on the evidence within research that industry clusters, and particularly creative clusters, resemble complex adaptive systems. If this is held to be true, then traditional methods for analysing how clusters emerge and evolve over time are inadequate for explaining the multitude of dynamic paths they can take. Complexity theory provides a different lens from which to study clusters and highlights the importance of endogenous factors and more significantly the crucial role of interactions between agents in the cluster.

Complexity leadership theory offers a model to explore these interactions and analyse how they lead to the emergence of complex systems such as clusters. It appears to be an especially appropriate framework for analysing creative clusters, which rely heavily on knowledge networks and the development of innovative products and processes.

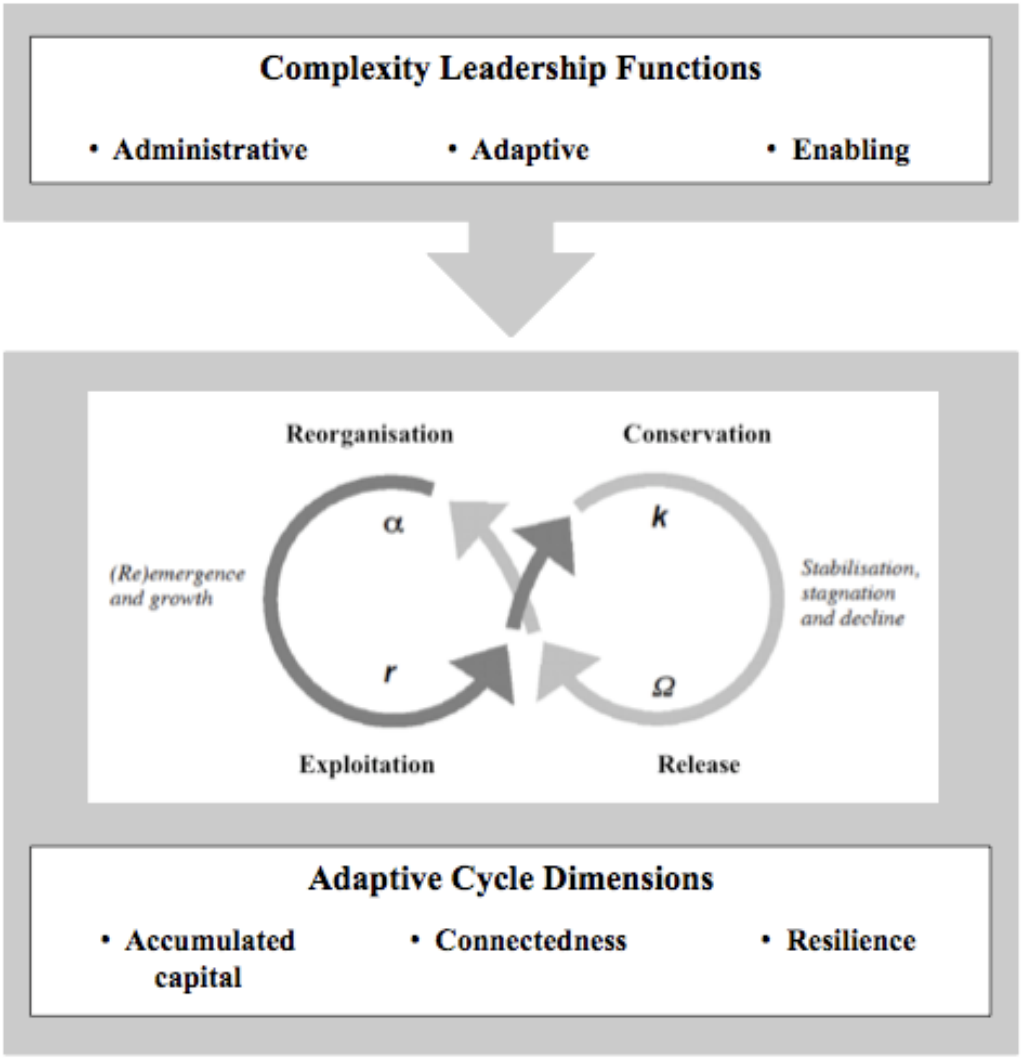
This thesis therefore analyses the East London cluster from the perspective of it being a CAS and attempts to assess what stages of an adaptive cycle it appears to have gone through to date. This is done by measuring the development of the key dimensions of accumulated capital, connectedness and resilience that shape the clusters path through the cycle.

The role of complexity leadership will be analysed in terms of evaluating the contribution of different leadership functions to the development of the cluster across the phases of an adaptive

cycle. Complexity leadership theory has informed the three leadership functions adopted for the analysis: administrative, adaptive and enabling.

The framework (Figure 8) will serve as a basis to identify if different leadership functions have affected certain adaptive dimensions and played different influencing roles as the cluster has evolved. The role of leadership in influencing the cluster's evolution to date may provide insight into the possible future pathways that may develop.

Figure 7 - Conceptual framework



Chapter 3: Research Design and Methods

This chapter describes the research methodology that was adopted for the thesis. It starts with the key research questions and then explains the strategy adopted to answer these questions. Theoretical concepts from Chapter Two are then operationalised with data collection and analysis methods detailed. It concludes with a discussion on research limitations and how challenges to validity and reliability have been addressed.

3.1 Research Questions

The research being conducted for this thesis consists of a descriptive component that seeks to describe the main elements of the cluster and its emergence and a semi-explanatory component that looks at the role of leadership within the cluster. Complexity leadership theory is still in its infancy as an area of study, therefore its application as an analytical tool is still exploratory in nature. The central research question being posed is:

> *What role did different complexity leadership functions play in the development of East London's creative digital cluster?*

While this illustrates the main research topic, it does not necessarily explain what will be the specific focus of the study. It is suggested that the development of research sub-questions and propositions can guide a research and better clarify its scope (Yin, 2003). The guiding questions for this thesis are:

- *How closely does the cluster's development reflect the early phases of an adaptive cycle? How have the adaptive dimensions of accumulated capital, connectedness and resilience changed over time?*

The creative digital cluster in East London displays some of the key characteristics of a complex adaptive system. Applying this assumption, it is proposed that changes to key dimensions within the cluster during the last 5-10 years will resemble those in the phases of reorganisation and exploitation within the adaptive cycle model.

- *What strategies within administrative, adaptive and enabling leadership functions have been important in the development of the cluster to date?*

It is assumed that some key events or decisions by certain individuals and organisations will be identified as of being influential in the cluster's development. It is proposed that these can be mapped to relevant complexity leadership functions.

- *Which of these leadership functions have been most influential at different phases of the cluster's evolution?*

It is proposed that some complexity leadership functions will have had more impact on adaptive dimensions than others at different stages of the adaptive life cycle.

3.2 Research Strategy

This thesis adopts a case study research strategy because specific leadership functions and actions cannot be analysed in isolation of the cluster environment in which they were made. A case study approach is more suitable than other approaches when the contextual environment is important to understanding the topic being studied (Baxter and Jack, 2008). In addition, Yin (2003) suggests that it is an appropriate choice when the desire is to get a deep understanding of a situation and/or to answer descriptive or explanatory questions. It is suitable for the study of contemporary events that the researcher has no control over (Yin, 2003). Both of these criteria are relevant to this thesis.

A single case study has been chosen for analysis as opposed to multiple cases because of the unique characteristics of this case. The cluster has emerged at a time when most regions in Europe have experienced a decline in economic development and growth. It also appears that the cluster's dynamism is based on new relationships being developed between previously unconnected knowledge based industries (Foord, 2013).

The case study relies predominantly on qualitative data, with some quantitative components utilised to support explanation and pattern building. Qualitative research is said to be appropriate for analysing objects in their natural environment and when attempting to make sense of meanings that people give to events and processes (Denzin and Lincoln, 2011). This approach complements the objectives of this thesis research, which seeks to explore how cluster participants interpret which leadership events and outcomes enabled the cluster's evolution. It has also been suggested that the dynamics of cluster development can only be fully encapsulated through the use of qualitative research methods (Wolfe and Gertler, 2004).

3.3 Operationalisation: Variables and Indicators

In order to conduct the research required for this thesis, it is necessary to transform the theoretical concepts described in Chapter 2 into more analytical components. Operational definitions are provided for each of the functions of complexity leadership and the dimensions of the adaptive cycle. Subsequently, these definitions are broken down into variables and indicators that are more easily measurable.

Due to the relative newness of adopting complexity thinking to both economic and leadership theories, there is limited literature that can guide the choice of appropriate variables for their study. The selection of variables and their interpretation within this thesis therefore rely on academic definitions of key terms and the researcher's understanding of concepts in view of their application to industry clusters.

3.3.1 Adaptive Cycle Dimensions

As noted, the evolution of an industry cluster can be conceptualised using the adaptive cycle model. The stages within the cycle and the future state of the system are shaped by the influence of three dimensions whose definitions are taken from Martin and Sunley (2011, p19):

Accumulated capital – the accumulation of productive, knowledge and institutional capital within the cluster.

Connectedness – the level of traded and untraded interdependencies among cluster firms and institutions.

Resilience – the capacity of cluster agents to respond flexibly to changes internal or external to the cluster.

These dimensions have been subdivided into variables that are adapted from analytical interpretations derived from literature and policy based documents. The descriptions of these variables as used for this research include:

- Productive Capital – the capability of firms, the quantity and quality of local workers, amount of supporting finance and physical infrastructure within the cluster (adapted from Martin and Sunley, 2011; Simmie and Martin, 2010).
- Knowledge Capital – the level of data, intellectual property, cluster brand equity, cluster network depth and system knowledge that improves cluster efficiency and effectiveness (adapted from OECD, 2013).

- Institutional Capital – the specific conditions in the cluster's internal and external institutional environment that allow it to grow and enhance its competitive advantage (adapted from Bresser and Millonig, 2003).
- Traded interdependencies – the market exchange of goods and services or transaction based agreements between producers and suppliers within the cluster (adapted from Storper, 1995; Martin and Sunley, 2011; Menzel and Fornahl, 2007; Molina-Morales and Expósito-Langa 2012).
- Untraded interdependencies – the shared goals, common language and conventions and cooperative networks that form within a cluster (adapted from Storper, 1995; Martin and Sunley, 2011; Menzel and Fornahl, 2007; Molina-Morales and Expósito-Langa 2012).
- Creativity – the level of entrepreneurialism of the cluster and the willingness of its firms and institutions to innovate (adapted from Simmie and Martin, 2010).
- Flexibility – the openness of the cluster and its agents to new entrants and new business patterns (adapted from Simmie and Martin, 2010).

These variables and their associated data collection methods and sources can be found in Table 3.

3.3.2 Complexity Leadership Functions

Complexity leadership theory generally indicates three functions of leadership as necessary for managing complex adaptive systems. The following definitions are used to depict each function in the context of the creative digital cluster:

Administrative leadership – the actions of individuals and groups in formal, or semi-formalised, organisational roles that involve strategic planning and coordinating of the cluster.

Adaptive leadership – the adaptive and creative actions that emerge as a result of informal interactions between individuals, firms and institutions within the cluster and with the external environment.

Enabling leadership – actions that a) foster enabling conditions that allow adaptive leadership to emerge; and b) manage the entanglement between formal and informal leadership within the cluster and its agents.

(Adapted from Uhl-Bien et al., 2007).

These leadership functions have been broken into specific strategies and actions that individuals take to enable complex adaptive dynamics (Table 4). It is important to note that adaptive leadership is generally a product of administrative and enabling leadership actions. Strategies are based on notions derived from literature and previous empirical studies. The definitions of these variables as used for this research include:

- Orientating – the strategic planning and formalised vision building for a cluster (adapted from Uhl-Bien et al., 2007; Schreiber and Carley, 2006).
- Coordinating – the acquisition and allocation of resources to support cluster development (adapted from Uhl-Bien et al., 2007).
- Directing – the implementation of policies or procedures that work to develop a more favourable environment for cluster growth (adapted from Uhl-Bien et al., 2007).
- Improvising – the ability of agents within the cluster to take risks and identify new opportunities (adapted from Nooteboom and Termeer, 2013).

- Reframing or reformulating – the transformation or reorganisation of existing ideas or resources within the cluster to produce new outcomes (adapted from Uhl-Bien et al., 2007; Lichtenstein and Plowman, 2009; Nooteboom and Termeer, 2013).
- Sensemaking – the ability to recognise new system identities, make correlations and give meaning to actions and events within the cluster (adapted from Lichtenstein and Plowman, 2009; Nooteboom and Termeer, 2013).
- Connecting – the linking of different visions and objectives between cluster agents at different geographical or institutional levels (adapted from Nooteboom and Termeer, 2013).
- Fostering interaction – the creation of networking events and spaces that enable interaction between agents in the cluster (adapted from Uhl-Bien et al., 2007).
- Fostering interdependency – the promotion of working groups and collaborative partnerships that generate interdependent connections within the cluster (adapted from Uhl-Bien et al., 2007).
- Injecting tension – the injection of diverse agents and ideas to a cluster and the promotion of a sense of urgency to its growth (adapted from Uhl-Bien et al., 2007; Lichtenstein and Plowman, 2009).
- Integrating – the integration of knowledge and ideas between scales including bottom-up feedback and macro scale knowledge distribution within the cluster (adapted from Uhl-Bien et al., 2007; Nooteboom and Termeer, 2013).

Table 3 - Adaptive cycle dimensions operationalisation

Dimensions	Variables [codes used within ATLAS.ti]]	Indicators	Data Collection Method	Sources
Accumulated Capital	Productive [PR]	Amount of workspace Amount of capital Number of skilled employees	Secondary Data – Reports, Statistics Qualitative Data – Interviews	Office for National Statistics; UK Government (online); Greater London Authority (online); Tech City Third Anniversary Report Tech City Futures Report; The Guardian; The Independent; WIRED.co.uk; Foord, 2003 (academic article); Tech City Cluster representatives; UK Tech and Business Alliance; Entrepreneur First; Digital Shoreditch; Shoreditch works; University College London; Other key respondents
	Knowledge [KN]	Intellectual property Knowledge spillovers R&D Investment Brand equity	Secondary Data – Reports, Statistics Qualitative Data – Interviews	
	Institutional [IN]	Supportive structures Supportive regulations Norms and values System identification	Secondary Data – Organisational Reports Qualitative Data – Interviews	
Connectedness	Traded interdependencies [TI]	Supplier relationships Cooperative partnerships Common assets	Secondary Data – Organisational Reports Qualitative Data – Interviews	
	Untraded interdependencies [UI]	Shared goals Common language Advisory networks	Secondary Data – Organisational Reports Qualitative Data – Interviews	
Resilience/Adaptive capacity	Creativity [CR]	Entrepreneurialism Firm innovation Institutional innovation Risk acceptance	Qualitative Data – Interviews	
	Flexibility [FL]	Diversity Level of openness Amount of different investment models Level of reskilling	Qualitative Data – Interviews	

Based on Martin and Sunley, 2011; OECD, 2013; Bresser and Millonig, 2003; Storper, 1995; Simmie and Martin, 2010; Molina-Morales and Expósito-Langa 2012.

Table 4 – Complexity leadership functions operationalisation

Leadership Functions	Strategies [codes used within ATLAS.ti]	Actions	Data Collection Methods	Sources
Administrative Leadership	Orientating [OR]	Vision Building Planning Evaluation	Secondary Data – Organisational Reports; Government Reports; Media articles; Academic Journals Qualitative Data – Interviews	Office for National Statistics; UK Government (online); Greater London Authority (online); Tech City Third Anniversary Report Tech City Futures Report; The Guardian; The Independent; WIRED.co.uk; Foord, 2003 (academic article); Tech City Cluster representatives; UK Tech and Business Alliance; Entrepreneur First; Digital Shoreditch; Shoreditch works; University College London; Other key respondents
	Coordinating [CO]	Acquiring resources Allocating resources		
	Directing [DI]	Establishing policies and procedures Allocating tasks		
Adaptive Leadership	Improvising [IM]	Taking risks Allowing experiments Looking for new opportunities Reorganising resources		
	Reframing or reformulating [RF]	Changing scales Adopting different perspectives		
	Sensemaking [SM]	Generating new understandings Developing common language Leaders accepting 'Tags'		
	Connecting [CN]	Making linkages between: • People • Businesses • Macro-micro levels • Visions		
Enabling Leadership	Fostering interaction [FI]	Establishing working groups Creating network events Creating interactive spaces		
	Fostering interdependence [FD]	Developing co-ordination rules Creating partnerships		
	Injecting tension [TE]	Surfacing of conflicts Creating a sense of urgency Injecting diversity (people, ideas)		
	Integrating [IT]	Providing bottom-up feedback Championing new ideas Monitoring the environment for relevant information		

Based on Uhl-Bien et al., 2007; Lichtenstein and Plowman, 2009; Nooteboom and Termeer, 2013.

3.4 Data Collection Methods and Sampling

In order to conduct the case study research, two specific data collection methods have been utilised: qualitative and secondary data collection. The following section will detail how each method supports the case study methodology and how it relates to the operationalisation of theoretical concepts. The appropriate sources for each collection method will also be outlined.

3.4.1 Qualitative data collection

Qualitative methods are appropriate for the case study approach adopted for this thesis as a key objective is to analyse the perceptions of what leadership functions and strategies have influenced the cluster's development. This generally produces responses that cannot be easily quantified but are important to understanding the complexity of interrelationships between agents and their environment. Qualitative data also provides evidence as to the perceived level of adaptive cycle dimensions as the cluster has developed. The dimensions of capital and connectedness may lend themselves to more quantitative approaches but resilience is typically measured by individual's reflection of the adaptability of their institution or the system.

Semi-structured interview methods form the basis of this qualitative approach. As the thesis adopts established theoretical concepts for its lens, it is appropriate that interview questions with key participants were framed with these concepts in mind. This is not a completely exploratory thesis as it is utilising established complexity based models to describe and explain aspects of the cluster's evolution. Member checking has also been adopted to verify and assess responses given by key participants.

3.4.2 Description of sample

A purposive maximum variation sample of the cluster population was targeted for the semi-structured interviews. It was important to gain access to people who were close to key decisions or events that helped shape the cluster, or who had an understanding of how the cluster operates as a macro system. A non-homogenous group was required for sampling as research highlights the shared responsibility and influence of multiple stakeholders (namely public, private and research sectors) in cluster development (Sölvell, 2009).

Email and phone invitations were sent to 40 contacts that were considered to have direct involvement or an in-depth understanding of the East London cluster with 16 agreeing to be involved in semi-structured interviews. These individuals included representation from entrepreneurs, local government, central government (via government agencies), accelerators, consulting firms, education institutions, venture capitalists and the media. City government in the form of the Greater London Authority was contacted but requests were not successful. Due to time constraints, it proved difficult to get an appropriate balance of different stakeholders. This would have allowed for a greater comparison of differences in stakeholder perceptions between groups.

A full list of participants can be found in Annex 1. Most interviews were conducted face-to-face, except for three participants who were involved in phone interviews. Questions were context specific, but a general outline of common questions can be found in Annex 2. References to interviewees as sources of information will be marked where appropriate by the letter 'I ' and a number, for example - (I6).

3.4.3 Secondary data collection

In order to address issues of internal validity with the case study methodology used for this thesis, it was important to draw on secondary data to support qualitative evidence. Secondary data was used to not only evaluate adaptive cycle dimensions within the cluster area but also to analyse external perceptions of key leadership strategies. A stronger narrative emerged and patterns were identified by the triangulation of data.

Secondary data sources for analysing complexity leadership variables included government reports, government announcements, media articles, journal articles and cluster initiative evaluation reports. All these sources were generally available online publically or via academic subscriptions to journals. Additional secondary data was sourced from key participants as qualitative data collection progressed. In addition, quantitative secondary data was sourced where possible from government statistic websites and cluster reports to support analysis of adaptive cycle dimensions, especially levels of capital.

3.4.4 Data collection phases

The first phase of collecting information was secondary data collection by way of desktop research. This involved accessing publically available documents, datasets and articles related to the cluster and/or the designated cluster geography. Initial scans of documents and basic data manipulations occurred. It formed the basis for structuring the interview guidelines and identifying key respondents for the interviews in the next phase.

The interview phase was conducted in a semi-structured manner with open questions directed towards gaining information about the indicators identified in the operationalisation. Interviewees were provided with an overview of the aims and objectives of the research but loaded questions were avoided to ensure that the outcome of the interview was not completely deterministic. Throughout the interview phase, interviewees directed the researcher to further secondary data sources and additional contacts that supported data collection.

Member checking of information regarding key dates or specific names was continually conducted throughout the interviews. Participants were also given the chance to provide additional feedback or responses post interview if necessary.

3.5 Data Analysis Methods

Yin (2003, p.109) suggests "every case study should…strive to have a general analytical strategy". This helps to avoid a situation where numerous data is collected but the researcher has no systematic structure for analysing or presenting it. This thesis has adopted an analytical strategy that focuses on addressing theoretical propositions that were developed through the review of literature in Chapter Two.

A form of time series analysis was used to specifically look at the chronological sequence of events and decisions that have led to the cluster's development. Attempts were made to identify specific time intervals and trace the use of complexity leadership strategies over time. A triangulation of research methods and data sources was used to build this explanation. Chronologies can be used for explanatory research as well as descriptive (Yin, 2003). Linking changes in adaptive cycle dimensions and phases to specific complexity leadership functions and actions was used to make some casual inferences.

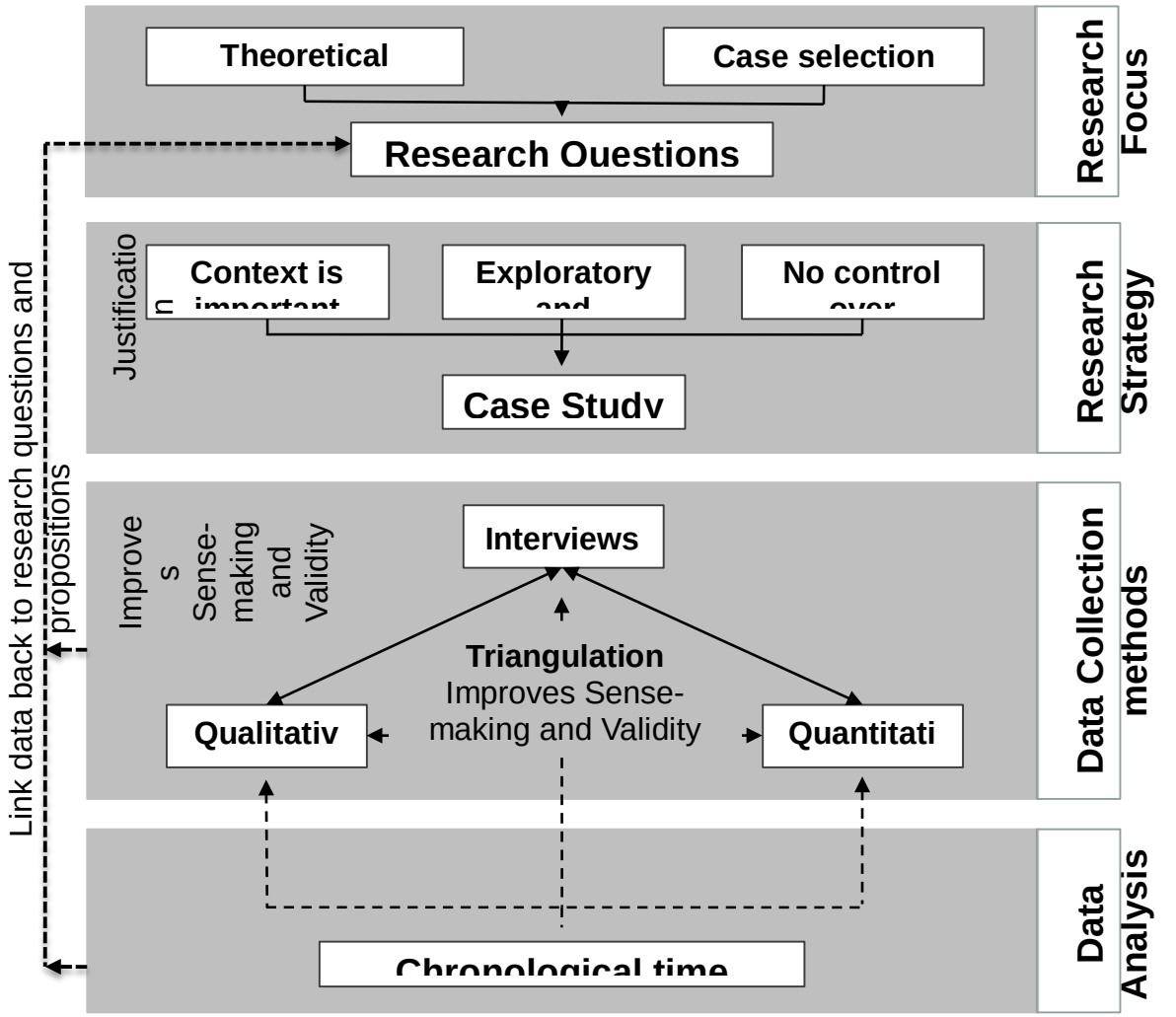
Qualitative and secondary data was analysed using text and audio analysis software (ATLAS.ti) that allows for coding of variables to identify patterns. Leadership actions and the qualitative adaptive cycle dimensions they supported were assigned codes as per Table 3 and Table 4. They were also assigned to different time periods to support chronological time series analysis. For example, the inter-firm afterwork BBQs were coded as [FI] [CN] [UI] [TI] [Pre-Tech City] to identify that they were an early stage strategy to foster interaction in order to connect individuals and enable collaborative outcomes. Time series analysis of secondary quantitative data was also conducted to highlight patterns in key adaptive cycle dimensions that were specific to the cluster's location.

Casual relationships between leadership functions and adaptive phases was established via measuring the number of types of leadership actions; the opinion of respondents; and analysing examples expressed in secondary data at different stages of the cluster's evolution.

3.6 Research Design Overview

To aid the understanding of the components of this research design and the linkages between them, a diagrammatic representation is presented in Figure 9. The research questions and propositions have informed the choice of research strategy, collection and analysis with findings then being linked back to these questions.

Figure 8 - Representation of research design



Source: Researcher's own adaption of principles and concepts from Yin (2003)

3.7 Validity and Reliability

There are generally four criteria that are used to assess the quality of empirical social research: construct validity, internal validity, external validity and reliability (Yin, 2003). Each criterion has implications for the case study approach adopted due to the large emphasis on qualitative data sources and will be addressed in the following sub-sections.

3.7.1 Construct Validity

Case studies are often criticised for not developing effective measures for the concepts they set out to analyse (Yin, 2003). To avoid this, the thesis has adopted a clear research design structure

that incorporates elements of Yin's (2003, p.21) five components of effective research design. As was shown in Figure 9, the research questions and propositions have been linked to what data is collected and how it is analysed. In addition, the variables and categories chosen to measure concepts of complexity leadership and adaptive cycles are based on relatively common descriptive indicators that have been applied to other cases. In addition, multiple data sources were used to build an appropriate evidence base including: targeted interviews, specific Tech City administrative documents, media articles, statistical data and academic articles.

3.7.2 Internal Validity

There is also the risk that any casual relations established within case study research fail to acknowledge other possible causal factors or include internal biases (Yin, 2003). This thesis acknowledges that other factors besides constructive forces (e.g. macro-events) have influenced the cluster's development and some of these factors, or rival theories, are included in the data analysis. In addition, qualitative research provides data that involves subjective interpretations of events and key decisions by both the respondents and the researcher. Triangulation of data collection methods and sources, as mentioned previously, will seek to address validity from the lens of the researcher. The process of member checking was structured to verify key information without influencing respondent interpretations and perceptions.

3.7.3 External Validity

When research is focussed on a single case, as in this thesis, there is the risk that any findings will not be generalisable to a wider setting (Yin, 2003). Qualitative and selective secondary data is highly contextualised to the phenomena or environment being studied. To overcome this, the research has been targeted towards specific theories that will make the findings analytically generalisable. Even though the location and characteristics of the cluster are unique, the concept of clusters as CAS and the application of complexity theory models to their study are not. Therefore, other researchers could apply similar theoretical frameworks to the study of other industry clusters and compare findings.

3.7.4 Reliability

The final criteria for judging the effectiveness of research focuses on whether a researcher conducting the same study would arrive at the same conclusions (Yin, 2003). This is a challenge within case studies due to the open and subjective nature of some data sources and researcher analysis. This thesis seeks to address this by being as transparent as possible regarding case study choice, theoretical framework, data collection and data analysis methods – essentially utilising the sub-sections within this document as a case study protocol. A case study database is also utilised which consists of all notes, supporting documents and data that is then specifically referred to within the data analysis section.

Qualitative research is often an iterative process where findings or analysis is incrementally built up. To aid readers of the thesis in understanding the constructive nature of the research, an abbreviated version of what Silverman (2000, p.236) refers to as a 'natural history' of research is included in Annex 3. It explains, in diary form, my personal relationship to the topic and the ongoing development of concepts, methods and analysis as the thesis progressed.

Secondary data can both improve the validity of the research by providing alternative measures of key concepts and also weaken validity if the data sources are too homogenous. Reports produced by organisations or individuals that represent key qualitative respondents may suffer from the same internal biases and therefore tell you nothing new. It was important therefore to select a variety of secondary data from different sources. It was also essential to be aware of the different motivations behind the production of this data and the perceived quality of the data for accurate analysis.

Chapter 4: Findings and Analysis

This chapter presents the main findings based on the analysis of data obtained through semi-structured interviews and secondary sources.

It begins with a description of the East London creative digital cluster. This is followed by a chronological narrative of the evolution of the cluster based on interview participant's accounts and desktop research.

Section Three looks at the applicability of different cluster theories in encapsulating the cluster's evolution and section four focuses on analysing it from the perspective of an adaptive cycle.

Section Four utilises complexity leadership theory as a model to identify relevant key actions and events that helped shape the cluster. The final section compares the role of different complexity leadership functions between the phases of the adaptive cycle that the cluster has gone through.

4.1 Description of case

Defining the cluster being analysed for this research proved more difficult than initially assumed. Different interpretations exist amongst interview participants, media and individual organisations as to what industries and institutions make up the cluster's base and how far the cluster's geography extends to. This is not altogether surprising, as even Porter himself has provided only vague suggestions of what designates institutions and firms as being linked in a cluster and what 'geographical proximity' refers to (Martin and Sunley, 2003).

The research also relies on the assumption that the cluster operates as a CAS and there appears surface evidence to support this. The cluster contains properties of emergence and self-organisation in terms of a macro level identity and structure emerging out of individual actions without a central controlling mechanism. Many participants in the research stressed the organic nature of the clusters development and that everyone was contributing to its growth (I1;I5;I7). Analysis by Foord (2013) suggests that the cluster is generating the necessary networks and weak ties to manage uncertainty within the system. He also alludes to the non-deterministic nature of the cluster with the influence of different dynamics resulting from increased attention being still unknown.

4.1.1 Cluster makeup

The mixed identity of the cluster is highlighted by the many terms that have been used to describe it. Including branded names such as Silicon Roundabout, Digital Shoreditch and Tech City, it has also been labelled in different contexts as a tech cluster, a creative digital cluster, a creative technology knowledge cluster and a cluster of start-ups.

The cluster is generally concerned with firms operating in what has been termed the digital economy (see Appendix 1 for a full list of relevant sub-sectors). This includes firms manufacturing and distributing IT hardware and also those developing software or working with digital based data. However, descriptions of the cluster tend to centre more on businesses working within creative digital content industries. Core businesses are described as those who have blended the use of technology with design to deliver creative advertising, promotion and social media strategies for different clients (Foord, 2013). However, the concept of 'creative tech' now seems to encapsulate a multitude of different firms using technology to creatively disrupt traditional business models in a variety of industries.

> *"There's an extraordinary cross-fertilisation going on between a number of different creative, not so much disciplines but certainly different creative sectors*

and one thing that is beginning to weld all of this together, to create this kind of fusion, this creative fusion... is of course the creative tech sector… it's that digital platform" (I3)

Most of the firms that self-identify with the cluster are involved with digital data analytics, social media analytics, web and applications design, digital advertising and PR, software development and a range of related consultancy work (Nathan et al, 2012; WIRED UK Staff, 2010).

Sample studies (Nathan et al, 2012; Foord, 2013) have also demonstrated the abundance of early stage, micro-size companies in the area, hence the ubiquitous of the term 'start-ups' when talking about the cluster.

4.1.2 Cluster geography

There is a general consensus that the heart of the cluster lies in Shoreditch, a district located at the southern edge of the inner East London Borough of Hackney. The inner area centres on the districts of Hoxton and Shoreditch with a concentration of activity around the Old Street roundabout. However, the boundaries of the cluster are open to more debate. Government actors have played a large role in trying to extend the cluster's development further east to embrace the Olympic Park site in Stratford. Local entrepreneurs have been reluctant to acknowledge this expanded definition but are themselves moving to locations further removed from Shoreditch. New working spaces and accelerators have been opened in areas that include Haggerston, Hackneywick, Clerkenwell, Whitechapel and even Canary Wharf (see Figure 10).

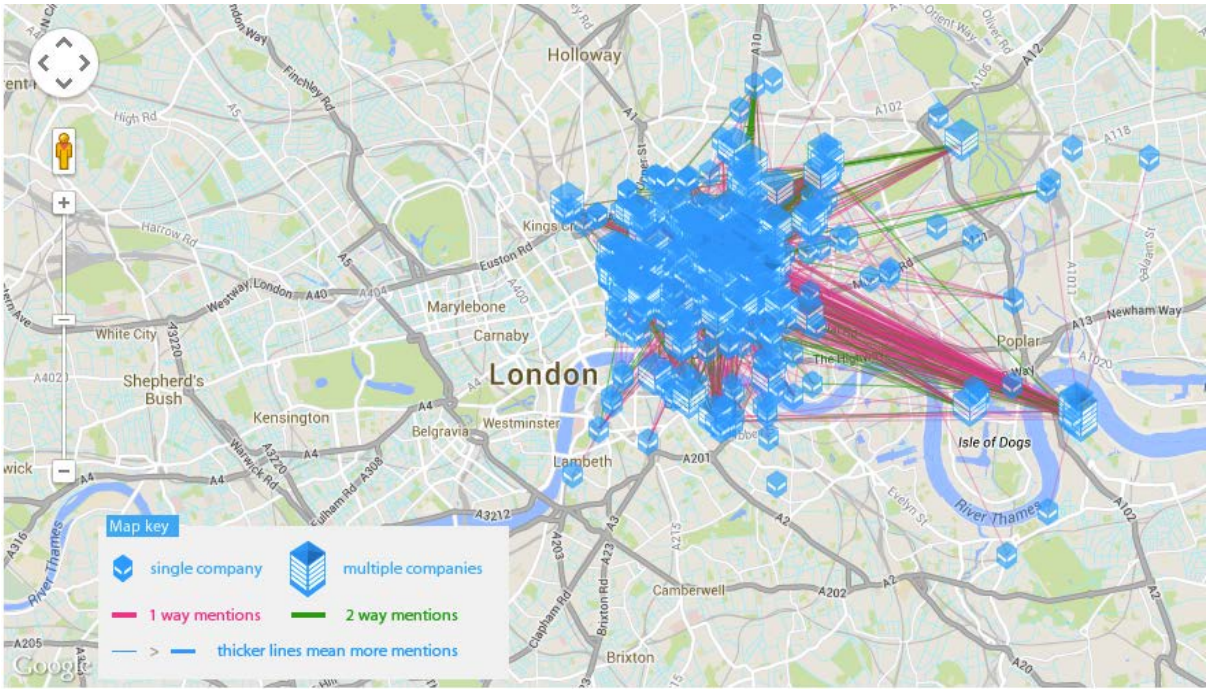
Figure 9 – Cluster geography

Source: Google Maps, 2014

It is quite normal for a cluster to generate different focus areas and even sub-clusters (Menzel and Fornahl, 2007). This is what is likely occurring with the East London cluster, as new areas

emerge focussed on different tech niches. Cluster boundaries can only really be estimated based on where the level of connections between firms and institutions start to decrease (Menzel and Fornahl, 2007). A suitable measure therefore for analysing the boundaries of the East London cluster is by using Tech City Map, a web based application that maps connections between businesses via the social media platform of Twitter (see Figure 12). This can provide an approximation of the weak edges of the cluster based on where mentions between firms start to weaken. As the map shows, the cluster now extends connections across East London and even over the Thames River to the south.

Figure 10 - Tech City Map - A Map of connected firms within the cluster using social media networks



Source: Trampoline Systems, 2014

4.2 Descriptive narrative: The story of Tech City

This section provides an overview of the cluster's evolution. It is an attempt to account for the key events and actions that are associated with its development up to 2014. It is limited by the availability of historical accounts and interview participants recollections.

4.2.1 Creative roots

The East London cluster has its roots in the small creative enterprises that have been operating in the area for decades (Biddulph, 2012). As one participant noted:

> *"I have to say that basically…Tech City has been going for about 25 years. It's been evolving out of the arts, that's where it's sort of come from"* (I3)

The City Fringe, an area of inner London to the north and east of the City of London, has had a long connection with creative industries, being home to the design and manufacturing of jewellery, furniture and clothing for centuries (Bagwell, 2008 in Foord, 2013).

> *"If you look at that area, if you move to the west of the Old Street roundabout the design and crafts community has always been in that area"* (I11)

Spitalfields, an area next to Shoreditch, can trace its creative origins to the arrival of the French Huguenot silk weavers in the seventeenth century (Ranger, 2014; I3). In the 19th Century, Hoxton and Shoreditch were the primary location of London's furniture industry. The areas

were also well known places for Victorian era entertainment being home to a large number of music halls and theatres (Green, 2001)

Mid 20th century deindustrialisation due to increased globalisation led to many East London craft industries and light manufacturing companies closing down or relocating (Foord, 2013; Green, 2001). Warehouses were abandoned and job losses were extensive. For example, during a five-year period in the late 1970s alone an estimated 3000 jobs were lost in the south Shoreditch area (Pratt, 2009).

Running parallel to the decline of traditional industries, however, were the beginnings of a creative artists community in the City Fringe. Numerous collective artists studios appeared across inner East London in the 1970s. This was the resulting combination of a number of forces including: a surplus of Fine Arts graduates in the 1960s needing affordable working space; the opportunistic actions of some innovative artists organisations; and supportive, although perhaps unintentional, planning policy changes by the Greater London Council (Green, 2001).

Changes to the planning scheme in the late 1980s, namely to the Use Classes Order, also helped introduce more mixed use zoning to the area. This in turn enabled some enterprising artists and developers to begin to market new spaces that were taken up by artists looking to establish their own smaller independent studios (Pratt, 2009). This, combined with the opening of gallery spaces and the attraction of some artists who later became the commercially successful Young British Artists (YBAs), led *The Independent* in 1990 to describe "London's East End" as having "the biggest concentration of artists in Europe" (Alberge, 1997 cited by Green, 2001)

Artists continued to move into abandoned warehouses and retail spaces in the Hoxton/Shoreditch area in the 1990s (GfK, 2013). As attention grew, other creative businesses in the fields of design, advertising, architecture and photography also moved in. The professional design and creative advertising firms were particularly influential in East London with a cluster developing around Clerkenwell to the direct west of Shoreditch (Hutton, 2008; Foord, 2013).

The early artistic community, and later on the creative professionals, also created an environment for a diverse range of new entertainment venues. Coffee shops, bars and restaurants in the area began to increase steadily during the 1980s and 1990s catering to the area's new inhabitants and also in some cases providing complementary flexible work opportunities for fledging artists (Green, 2001).

4.2.2 New media and false beginnings (1995-2000)

The 1990s saw the emergence of a collection of 'new media' firms in the area who were exploring digital technology as a medium for delivering artistic content (Pratt, 2009). They were involved with the early beginnings of social networks, creative web design and later on the emergence of digital advertising and marketing (Pratt, 2009).

> *"When you look back towards the end of the 90s, there was an emergent IT cluster there. So there was a small number of businesses based in and around Hoxton square and one or two other parts of the neighbourhood that were pushing at the boundaries, you know pushing at the boundaries of where it was that sort of kinda the world of the digital medium and the software and the programming and those ideas were beginning to take us"* (I3)

As the hype over the internet and its potential increased in the late 1990s, these new firms, or 'dot.coms' as they were known, started to compete with artists and design firms for working space in East London (Hutton, 2008). In late 1999 and early 2000, there also began the beginnings of a backlash towards 'latecomers' to the rising internet boom. Criticism was aimed

at new businesses and individuals that were heavy on talk but lacked understanding of how to create an enterprise with true value (BBC, 2001a).

In mid 2000, global markets crashed and the dot.com bubble burst. Numerous businesses in the UK and overseas ceased operating, thousands of ICT workers lost their jobs and a large amount of venture capitalist money was lost. The media played a heavy role in creating just as much hype around the collapse as they did in spurring the speculative bubble (BBC, 2001b). Whilst East London experienced some negative effects from the crash just like other ICT focused areas in the UK, many of the early new media firms successfully fragmented and formed the seeds of new companies that built the beginnings of the current digital cluster (Pratt et al., 2007; Pratt, 2009).

4.2.3 Development of Silicon Roundabout (Mid 2000s-2010)

The early 2000s saw a decrease of tech related firms in the Shoreditch/Hoxton area. Many died during the crash and some left the area unable to afford increased rents due to residential growth driven by the popularity of 'creative' areas. Some also relocated as an attempt to not be associated with the negative publicity surrounding the crash and over-hyped new media companies (Pratt, 2009).

Despite this, the area continued to maintain a relatively strong artistic and design community due to its historical roots and connections between related industries. In addition, the range of bars and eating places as well as relatively cheap working spaces for inner London still made it an attractive place for young creative types.

The mid 2000s started to see a return to growth of innovative new digital based companies setting up around Old Street. Many were agency-based firms established by ex-employees of established companies in the Clerkenwell area (Ford, 2012). A lot of bootstrap businesses were operating out of shared offices to cut initial startup costs. Strong social networks developed from these co-working spaces aided by regular Friday night barbeques. Serendipitous meetings between individuals started to occur more regularly as the concentration of small tech firms grew. As one early mover recalls of that time:

> *"We're always bumping into start-up friends in the street, the café life is great, and there are regular rooftop barbeques at nearby Last FM and Moo on Friday evenings"* (Matt Biddulph, 2012, para.2)

Eventually networking moved from in-house barbeques to organised events. For example, MiniBar started operating in Shoreditch in 2006 as a social network evening offering people free beer and the chance to mingle with other start-ups, tech workers and investors (Open Business, 2006).

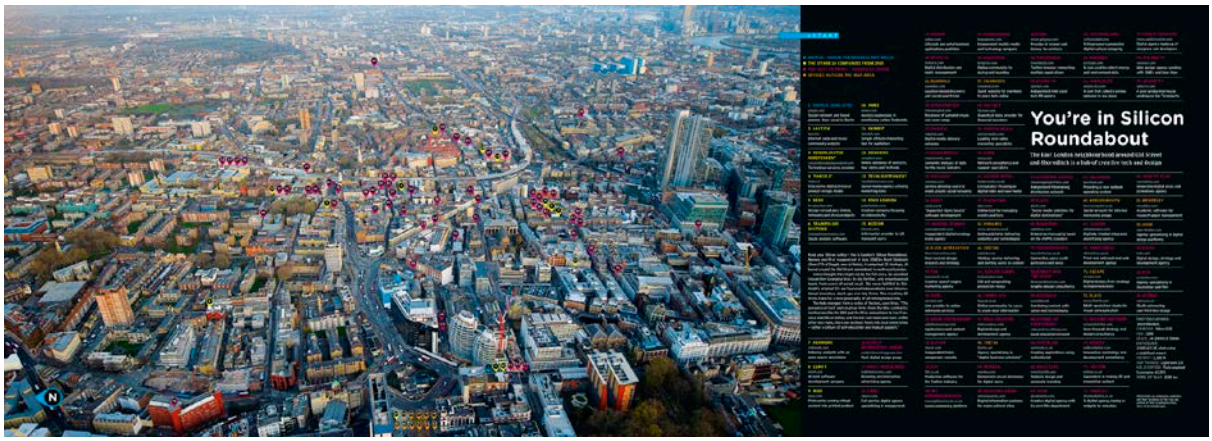
In mid 2008, a joke between friends began the development of an established identity for the area. Matt Biddulph, a developer subletting an office in Shoreditch, coined the name 'Silicon Roundabout' to describe the increasing number of tech start-ups co-locating around the Old Street roundabout (Biddulph, 2012). A subsequent tweet referring to the moniker (Figure 13), lead to stories being written up by the Financial Times, the Evening Standard and TechCrunch.

Figure 11 - Original 'Silicon Roundabout' tweet and Evening Standard article

Source: Biddulph, 2012

The name caught on and over the next year a number of individuals and organisations focused on building the cluster and creating more connections. In January 2010, WIRED Magazine produced a special edition mapping a list of 85 tech-focused start-ups in the area around Shoreditch (WIRED UK Staff, 2010) (Figure 14)

Figure 12 - WIRED.Co.UK's expanded list of companies



Source: http://cdni.wired.co.uk/static/20100129-Old-Street-Map.jpg

Around this time, businesses started to emerge specifically targeting the increasing amount of tech start-ups in the area. They focused on providing flexible co-working spaces to entrepreneurs and freelancers who wanted to be surrounded by similarly minded people in dynamic environments but who didn't want to commit to a lease. Many started offering additional services such as training, mentoring sessions and running events to connect start-ups to angel investors Some of the biggest success stories were the Trampery, set up in 2009, and Tech Hub, 2010, based on similar spaces that were proving popular in San Francisco and New York at the time (Neate, 2013; I8).

In 2010, an industry led community collective called Digital Shoreditch was established to shine a light on the "the outstanding talent in the digital media and technology community flourishing in east London." (PR Web UK, 2013). However, the community still faced challenges to its growth. Aside from accessing capital and talent, it was also proving difficult to obtain specific financial and legal advice for a sector that did not necessarily fall into mainstream categories or whose firms were too small.

In mid 2010, Matt Webb, a frustrated CEO of a design consultancy firm, attended a central government led trade mission to India. During this trip he managed to express his frustrations but also his optimism over the cluster's potential to the UK Prime Minister's senior policy advisor Rohan Silva (Cowan, 2013). These discussions formed the initial seed that by the end of the year had become the government's grand Tech City initiative.

4.2.4 Rise of Tech City (Post 2010)

By the end of 2010, the cluster was seemingly ready to move into a new stage of development that appeared to only really be deliverable via broader connections external to the cluster and a more supportive policy environment. As one participant puts it:

> *"It didn't need necessarily place-making help, what it needed was policy-making help and it needed a bit of a champion I think. It needed something or someone to say yes we really can be ambitious, we potentially can… rival some of our competitors"* (I14)

In November 2010, the UK Prime Minister David Cameron came to Brick Lane to set out his government's aim to "make East London one of the world's great technology centres and sow the seeds for sustainable growth throughout the economy" (HM Government, 2012, para.10). Cameron and his policy team saw the huge potential in promoting one of the only industries that was achieving growth post global financial crisis (GFC) in an area of inner London that was still relatively rundown (I7). They also took the chance to broaden the prospective geographic scope of the cluster by leveraging the development of the Olympic Park site in Stratford, to the further east of Shoreditch.

In Cameron's opening speech he acknowledged that the best way a government could help support a cluster is to "go with the grain of what is already there. Don't interfere so much that you smother." (HM Government, 2012, para.23). The central focus of the Government's work became using its influence and networks to bring attention to the cluster on a global scale. Using its international business promotion arm, UK Trade and Investment, the government set out to attract large multinational firms to directly invest in the area or provide specialist advice for tech start-ups (HM Government, 2012).

In March 2011, the Tech City Investment Organisation (TCIO) was launched to support the growth of the cluster. It began with three main objectives:

> *"1. To assist in securing Foreign Direct Investment in Tech City*
>
> *2. To engage with overseas VCs and help them to set up or start evaluating deal-flow in Tech City*
>
> *3. To support the cluster, and raise its profile internationally"* (TCIO, 2012, p.4)

A key part of the Government's strategy was the re-naming of the cluster. Silicon Roundabout lived on as a colloquial term used amongst local actors in the Shoreditch area, but Tech City became the new marketable brand for inner East London tech activities.

> *"the brand Tech city…it was very clear, simple, and easy to articulate globally"* (I14)

Whilst there were some criticisms of the name change, there seemed to be a general understanding that Tech City was more marketable on an international scale and may also have contributed to raising ambitions in the cluster (Solon, 2012a).

Boris Johnson, the Mayor of London, also got on board and used his internationally recognised position to market the mission to turn London into "the tech capital of the world" (Tolhurst, 2014, para.1). The work of TCIO and the Mayor's promotional vehicle, London & Partners, proved quite successful in raising the profile of the cluster, attracting investment and aiding local companies expansion into overseas markets.

> *"they poured a lot of fuel on the fire, tons of meetings and they also brought the big brands and others in, which is good…there have been some pretty good opportunities created for people"* (I5)

Large tech companies such as Google, Intel, Microsoft, IBM and Cisco all started to invest in Tech City. Specialist professional service firms such as KPMG and DLA Piper also began establishing presences in Tech City providing tailored support to start-ups.

The cluster was greatly boosted by the introduction of accelerator programs, which started operating out of incubators aimed at turning tech start-ups into high growth companies[1]. Some of the most popular included Seedcamp and Tech Stars.

During this period non-firm based organisations also started acknowledging and connecting to the cluster. Commercial partnerships and collaborative community focussed initiatives emerged aimed at seizing opportunities to achieve common commercial and social objectives.

Many of these new partnerships developed from networking which had become bigger and more organised. Events companies sprung up hosting regular meet-ups and targeted industry events. The cluster also extended its reach beyond London and the UK with major events such as the Digital Shoreditch Festival attracting international attention. The London Olympics hosted in East London in 2012 also provided a platform to showcase the clusters talent and growth to a world audience.

The focus on Olympic Park began the expansion of the boundaries of the cluster eastward. However, it was the rising costs of operating in locations that were now hugely popular with commercial tenants and opportunistic property developers that really drove the expansion.

> *"If you look at Shoreditch and Tech City and Old Street and all those areas…it's full, it's overcrowded, it's very expensive"* (I13)

The cluster has begun filling up the space between the two main financial hubs, the City and Canary Wharf.

There is also a perception now that the co-working spaces at the heart of the cluster are perhaps no longer the best environment for growing businesses that have moved on from the start-up phase.

> *"To be honest, what I found… is a lot of people are actually moving away from the co-working spaces as well because…you just don't get any work done"* (I8)

[1] Seed accelerators, or just accelerators, are fixed period programs that provide tailored training, mentoring and flexible working space as well as seed investment to early stage companies in exchange for equity. Start-up incubators are physical hubs that offer mentorships, specialist business advice and sometimes funding to grow early stage businesses.

People and companies are relocating, however, they are still keeping social and professional ties to the original cluster location (I8).

Specific thematic niches have also appeared within the cluster as digital technology started to merge with London's other key industry strengths. The suffix '–tech' has become an ubiquitous term to describe firms operating in these crossover markets, for example – ed-tech, fin-tech, fashion-tech. Some of these, such as fin-tech have grown rapidly due to London's historical position as a global financial capital and hub for associated talent.

> *"In terms of fin-tech, we're the world leaders, companies involved here are doing things nobody else in the world is doing"* (I9)

Specific incubators such as Level 39 in Canary Wharf and accelerators such as the Barclays Accelerator, run by Techstars, in Whitechapel are even specifically focusing on fin-tech start-ups.

The cluster as it stands in 2014 is both larger and more dynamic than what it was four years before. It is still expanding into new areas and attracting new players who will change the dynamics further. Challenges to its growth remain, especially in accessing talent and middle stage financing. However, there is an air of confidence amongst people working within the ecosystem that the market will naturally evolve to address these problems. There seems no doubt that the vibe within the cluster has moved on from the days of Silicon Roundabout. It is still a fun and creative place to work but with a strong, and continually growing, business edge to it.

> *"It was a bit of a playground but now it's somewhere to get work done"* (I5)

4.3 Analysis of cluster – evolution

This section analyses the applicability of different theories in describing the evolution of the creative tech cluster.

4.3.1 Traditional cluster theory

In terms of analysing what led to the emergence of the cluster, traditional cluster theory provides adequate explanation of why the cluster is located where it is. Porter (1998b) acknowledges the role of strategic resources, established related clusters and specialised local demand. There are obvious competitive advantages to the inner East London location, the proximity to the City of London and established artistic and design clusters provides strategic access to dynamic talent, demand for creative digital services and sources of financial investment.

The elements that attracted the tech start-ups to the area in the 2000s were similar to the key location reasons for new media firms in the 1990s: a vibrant artistic community; good night life; good coffee; and the relatively cheap rents for such close proximity to the city. As one early stage tech entrepreneur states:

> *"It's out of zone 1, so it's cheaper and out of the way of commercial streets full of shoppers*
>
> *It's near enough to The City, the West End and Canary Wharf to get to meetings, but has more of a casual character and streetlife*
>
> *Great food*
>
> *It's mid-gentrification and there are lots of good property deals on small rooms in soon-to-be-demolished office buildings*
>
> *Easy to reach if you're living in the cheaper areas of east and south-east*

London like Hackney" (Biddulph, 2012, para.5*)*

The key attractor though appears to be the concentration of creative and cultural activities that created a vibrant and energetic space for new businesses (Donovan, 2014).

> *"You know I think Bricklane has actually probably been more significant to the cluster…Bricklane was a vibrant artsy area, there was a lot of arts stuff around"* (I5)

Entertainment/hospitality venues around Hoxton/Shoreditch continued to attract new workers and residents, which in turn provided the increase in consumers needed for even more venues.

> *"There'd been a long sort of evolution of what had been going on in the area, I remember in Hoxton Square there was the Bluenote, Bedroom Bar….there were probably about four bars worth going to, and then it just picked up and picked up, until when the start-ups moved in there was definitely a feeling that there were lots of good places to drink, maybe playing cool music, slightly edgy, couple of good coffee shops arrived and then you're getting towards the key things we want"* (I5)

The urban fabric of the location and the type of establishments in the area were, and still are, important to its attractiveness. There seems to be no doubt that Shoreditch's gritty post-industrial look with more alternative entertainment options and working spaces has driven its appeal to hipsters and yupsters (young professional wannabe hipsters). As one participant suggests its:

> *"the reverse broken windows theory, in New York they were like we need to expunge every sense of graffiti there might ever be but for this community they kinda wanna see street art"* (I5)

The area's more alternative vibe is also considered to be a crucial element in generating new ideas and innovative practices.

> *"The noise, vibrancy, and underground attitude of East London certainly rubs off on you, and inspires fresh perspectives – something I think all these start-ups share. It's a million miles from sterile, air-conditioned Silicon Valley, literally and metaphorically." (Stiksel cited by Bradshaw, 2008, para.4)*

However, for most professionals there are limits to how 'grungy' an environment can be before it loses its attractiveness.

> *"We all want it to look a bit grunge but we don't want to be wading through mountains of shit as we walk down the street. Neither do we, every time we stick our head outside of the door to the street do we want to think we are going to get sort of beaten up or mugged"* (I3)

It is the balance of creative space and activities within a serviced and semi-regulated environment that makes the area so attractive to creative tech firms.

Traditional cluster theory is not necessarily adequate for analysing how an emergent cluster moves into a high growth phase. As Martin and Sunley (2011) argue, Porter himself does not offer much in the way of a theory of how clusters evolve over time. His main comments on the growth of a cluster mainly outline how more and more companies and entrepreneurs will relocate to an established cluster attracted by the level of innovation and productivity advantages it offers (Porter, 1998a). He describes how a cluster's success and potential for new opportunities generate political and institutional support which then reinforces the cluster's growth (Porter, 1998b).

Certainly, the East London cluster has become an attractive choice for entrepreneurs and investors looking for opportunities in the tech industry. There is also no doubting the virtuous circle nature of promotion and investment that has occurred in the last four years. However, traditional cluster theory is limited in explaining the range of endogenous and exogenous forces that have directed the cluster's path thus far.

4.3.2 Evolutionary economics

Evolutionary economics offers a greater explanation of the forces that drove early movers to the area. Boschma and Frenken (2011) have described how clusters can form out of the spin-offs of older companies and that related variety is an important aspect of cluster growth. Many of the early digital agencies in East London where formed out of the fragments of the first dot.com and new media companies, or employees leaving established agencies in Clerkenwell. The variety of different but supporting businesses and freelancers in the Shoreditch area, such as the bars, the cafes, the art galleries, the designers, the techies, the co-working spaces, have all helped to enable growth and innovation.

Some evolutionary economics research (Klepper, 2007 cited by Menzhel and Fornahl, 2007) suggests that clusters naturally appear as a new industry grows and concentrated pockets of specialisation emerge. There is evidence to support the argument that the growth in East London is part of broader national and international growth in the creative tech industry. It is certainly not the only tech cluster in the UK. The Cambridge tech cluster is both older and more well advanced then East London's.

There is no doubting, however, that the growth in this cluster has been quite considerable in recent times. Menzel and Fornahl (2007) argue that the key factors in transitioning an emerging cluster to a growing cluster are exceptional events or unexpected changes in exogenous factors. If we adopt this lens, it appears clear that the Global Financial Crisis (GFC) and some external trends played a part in the cluster's recent expansion.

The GFC played an influential role in releasing talent from large firms and providing the spark for many to turn towards working on ideas that had been developing but left unfulfilled during the growth years (I8; I12; I7).

> *"People who had good jobs were losing their jobs, lots of people applying for the same job and actually even if you get a job, is it safe? Are you gonna keep it for the rest of your life? So, the whole mentality has changed, so there was no excuse not to go out and build a start-up"* (I12)

The GFC also came at a time when new technology was not only generating new potential business models but also making it easier to enter the industry at low costs. Smart phones and their applications created new mechanisms for targeting consumers and the advances in basic computer hardware meant the barriers to entering the industry were much lower than before.

> *"The alignment in terms of the support network for entrepreneurs, the easy access to online services, the low cost of services, in terms of being able to build your apps or build your software…has made it a unique sort of environment in which now people can create their own jobs much easier and the ideas which they may have had in the last dot.com, when the infrastructure was not around or it was too costly to implement those ideas, you can now do them at significantly much, much less cost"* (I9)

There was also a growing amount of companies outsourcing advertising and design work. It offered freelancers in the area good day rates that then allowed them to pursue side projects, which often became the logic for new start-ups (I7).

In addition, one of the key drivers of the cluster was the increasing popularity of entrepreneurship in the late 2000s and the willingness of young professionals to take a chance starting their own companies. The media, with shows like 'Dragon's Den', and the wider society began to promote the idea of entrepreneurship as a viable and accepted alternative to a mainstream job (I6). In addition, large scale buyouts of tech start-ups such as Last.FM and Dopplr gained mass media attention and improved the attractiveness of going alone (Foord, 2013)

Menzel and Fornahl (2007) also cite transformative adjustments to organisational structures as factors that influence shifts between growth phases. The co-evolution of co-working spaces to incubators with attached accelerators was arguably quite a transformative change. Providing tech start-ups with extensive financial and knowledge-support within intensive collaborative programs is a step removed from simply placing them in close proximity to each other.

The expansion of the East London cluster into new geographical locations and thematic areas is also captured within evolutionary economics. Growing clusters are said to be able to integrate industries in adjacent areas or attract firms and institutions looking to orientate with the cluster's specialisation (Menzhel and Fornahl, 2007). Examples of this include the start-ups operating at the extended boundaries of this cluster that are integrating finance and fashion with digital technology.

Evolutionary economics would therefore appear to serve as a better explanatory tool than traditional cluster theory in this case. The development the cluster has gone through so far could even be conceptually representative of the first two stages of a basic four-stage life cycle model. More specifically: the emergence stage where a group of small firms emerge in a strategic location with a number focussed on adaptations of new technology; and the growth stage which is characterised by an increase in employment and firm density that contributes to increasing collaboration and innovation (Menzhel and Fornahl, 2007).

However, orthodox life-cycle models have some limitations in fully capturing the evolution of the East London cluster. Many explain the emergence of a cluster based on what Bergman (2007) describes as the existence of an innovative product, technology or industry in a favourable location. However, other areas in the UK and London were working with similar technology in the 2000s and often had better associated tech-based institutions and broadband infrastructure.

There is evidence to suggest that the current creative tech cluster is a regeneration of a tech cluster from the 1990s. However, this early concentration of new media firms never quite experienced the level of innovation or collectiveness associated with a typical growth stage of a new cluster before it crashed suddenly. In addition, most life cycle models explain renaissance in terms of replacement of original agents or outmoded systems from the original cluster (Bergman, 2007). But despite a slight exodus, many new media industry firms did not completely leave the area and either restructured or released talent that went on to form the basis of new start-ups. In addition, except for the rise in mobile applications, most new technology and business models were based on previous systems.

The rapid growth experienced by the cluster in the last four years also does not quite fit some established life cycle models. For example, Menzhel and Fornahl (2007) have described how heterogeneity declines as a cluster grows and the boundaries of the cluster narrow. This is clearly not the case in East London with new niches developing and the existence of what Martin and Sunley (2011) describe as "open innovation networks" (p.25).

An adaptive life cycle model may therefore prove more adequate for conceptualising the cluster's evolution. The rise and subsequent failure of the dot.coms around Shoreditch during

that time may approximate what Martin and Sunley (2011) describe as "emergent cluster failure" (p.36). It appears that firm failure rates were quite high during this period and the area never reached the stage where it was producing the positive externalities usually associated with industry clusters.

It can be argued that up until 2010 inner East London was experiencing the reorganisation of resources released from the dot.com collapse in 2000. Simmie and Martin (2010) suggest this release-reorganisation loop is characterised by innovation and experimentation, which is evident in the actions of the Silicon Roundabout entrepreneurs who were trialling new uses of different technology platforms and new types of working arrangements. It could also be argued that the cluster is recombining resources from even earlier creative clusters in the area in what Martin and Sunley (2011) describe as the "'rebundling' of legacies of the past" (p. 23).

The adaptive cycle model is also based on the understanding of clusters as complex systems with linkages across scales. Simmie and Martin (2010) describe how actions or events on a national or international level can affect the local level (downward causation) but additionally small-scale actions can have larger scale effects (upward causation). This is evident in the East London cluster where macro policies and events have influenced the behaviours of firms. But also the actions of cluster agents have influenced national policy and foreign direct investment levels.

4.4 Analysis of cluster – adaptive life cycle

This section will use the adaptive cycle model as a lens to describe the evolution of the creative tech cluster. The relevant changes experienced in the East London cluster since 2000 have been outlined in Table 5 and would appear to suggest that the area has moved through three phases of the adaptive cycle – release, reorganisation and exploitation.

Table 5 - Adaptive cycle phases apparent in East London cluster area

Adaptive Cycle Phases	Cluster changes experienced
Release: 2000 - 2002	Exodus of firms; Release of talent; Disinvestment
Reorganisation: 2002-2010	Increasing availability of workspace due to adhoc sharing; Increasing angel investments and return of venture capital Localised knowledge sharing via networks Establishment of initial identity – 'Silicon Roundabout' Inter-firm collaborations Rise in amount of start-ups
Exploitation: 2010-2014	Increase in venture capital; Larger scale working spaces or 'incubators' Established brand equity around 'Tech City' Supportive policy frameworks; Supporting accelerator programs Firm and institution collaboration; Network based working groups Development of sub-cluster niches; Introduction of new investment models; Increase in flexible business support products

The focus of the following sub-sections will be on changes to adaptive cycle dimensions identified within the reorganisation and exploitation phases. This is due to the limited amount of information regarding the release phase garnered by research participants and secondary data.

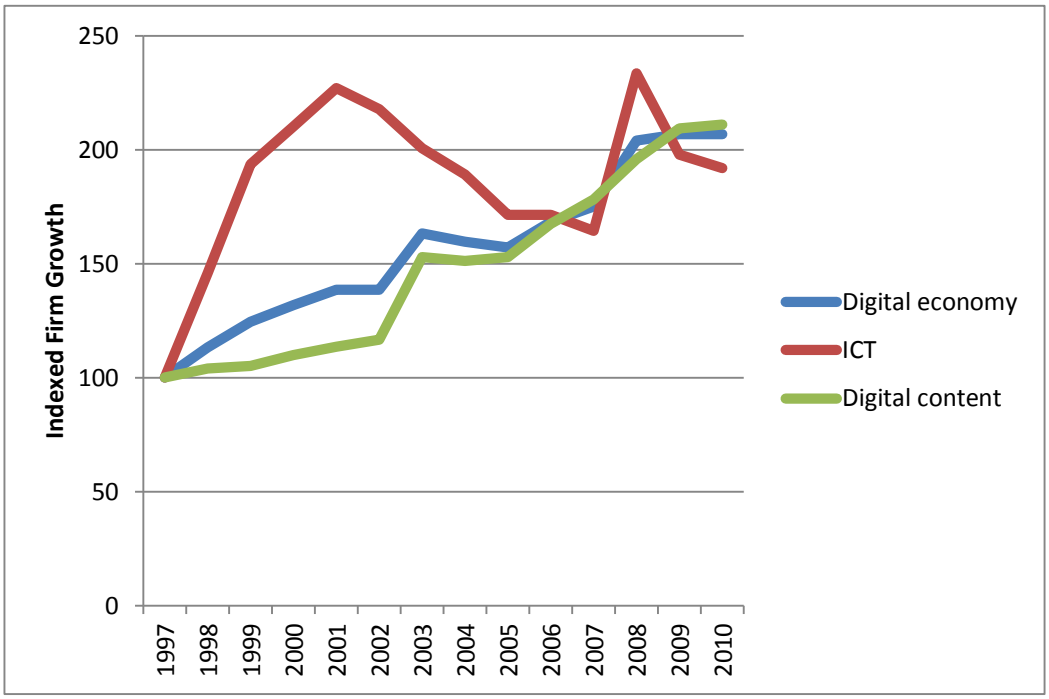
4.4.1 Reorganisation - 2002-2010

The reorganisation phase is postulated to have begun after the decline of investment and slowing of growth following the dot.com crash up to the establishment of the central government's Tech City initiative.

4.4.1.1 Accumulated Capital

Generally the reorganisation phase is marked by the growing accumulation of resources within the cluster area. *Tale of Tech City*, a report by the Centre for London, has highlighted the firm and employment growth in digital economy related sectors (ICT and digital content) in East London since the late 1990s (Nathan et al., 2012). As Chart 1 shows, the number of firms in both has increased considerably but the most consistent growth even through the GFC was in the digital content sector. This sector encapsulates most firms that would be described as creative tech.

Chart 1 – Inner East London digital economy firm counts 1997-2010



Source: BSD figures within Nathan et al., 2012

Similarly, both sectors have more than doubled in size in terms of employment numbers in the last decade. The digital content sector appears again to be the most consistent and extremely resilient, adding jobs even during the GFC (see Chart 2.)

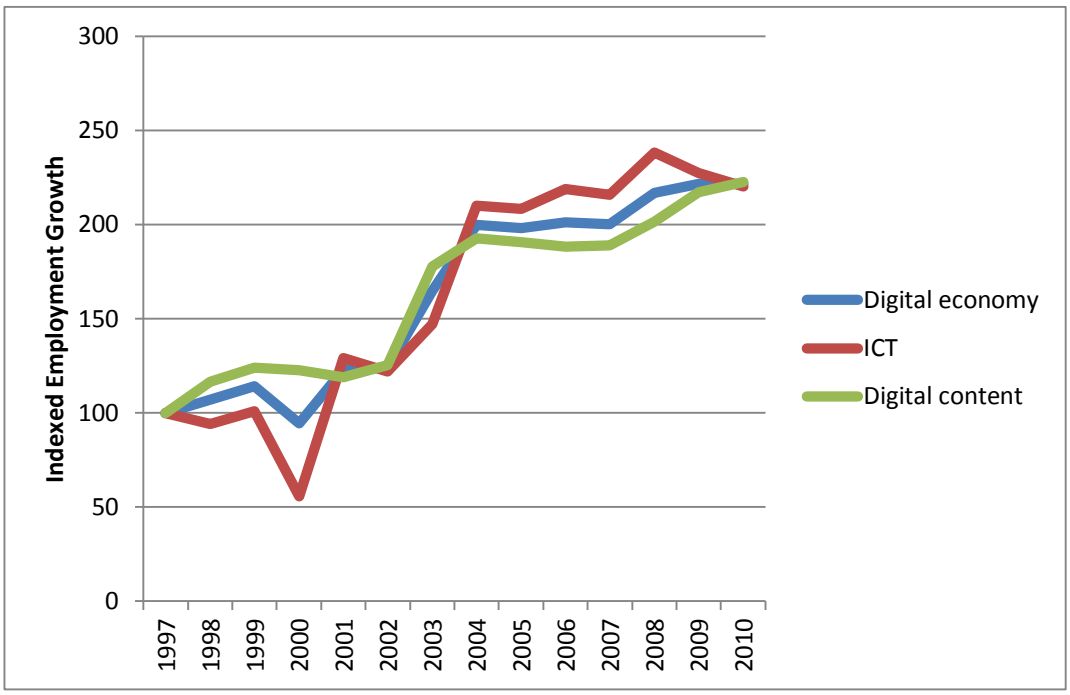
But firm and employee counts do not show the whole picture. There was clearly some growth in productive capital such as physical infrastructure during the latter half of the decade including the creating of co-working spaces that contributed to the potential of the cluster. Soft infrastructures such as networking events and clubs also supported connections between firms, investors and other organisations (I5; I7).

Knowledge capital also increased. The Silicon Roundabout brand gained more value as time went on as companies began to willingly self-identify with it (Wired UK Staff, 2010). As more and more companies moved into the area, the opportunities to share ideas and technology and learn from exiting companies increased (Bradshaw, 2008; I5).

Institutional capital was limited throughout this phase but towards the end of the period the introduction of dedicated co-working hubs with supporting services helped it improve (Foord,

2013; I8). Some policies such as the Entrepreneur's Visa were also being developed that would make the environment more favourable for start-ups (I14)

Chart 2 – Inner East London digital economy employment levels 1997-2010



Source: BSD figures within Nathan et al., 2012

4.4.1.2 Connectedness

During the reorganisation phase connectedness is suggested to be initially low but building (Simmie and Martin, 2010). This was the case in East London as small inter-workspace connections and basic supply relationships turned into inter-firm networks. Many local entrepreneurs starting sharing office spaces and resources to cut costs and freelancing was on the increase (I5; I7).

Untraded interdependencies were growing via informal networking events coordinated by different firms and 2010 saw the establishment of the first industry collective, Digital Shoreditch (Foord, 2013; I5). However, connections outside of the small group of innovative firms were low. There seems to be little evidence of targeted collaborative relationships with government, education or the community outside of normal day-to-day business ones.

4.4.1.3 Resilience

Cluster resilience is also said to be relatively high and increasing during this phase (Martin and Sunley, 2011). This seems to be the case here as the area was still experiencing business and employment growth during and post GFC. As Chart 1 and 2 have already highlighted the area proved quite resilient, not experiencing some of the large job losses witnessed in other sectors and areas of the country.

Entrepreneurs who were involved in the cluster during this period described their ability to adapt to changing workspaces and partnerships (I5). There is also evidence of the reorganisation of old dot.com firms with new business models (Biddulph cited by Bradshaw, 2008).

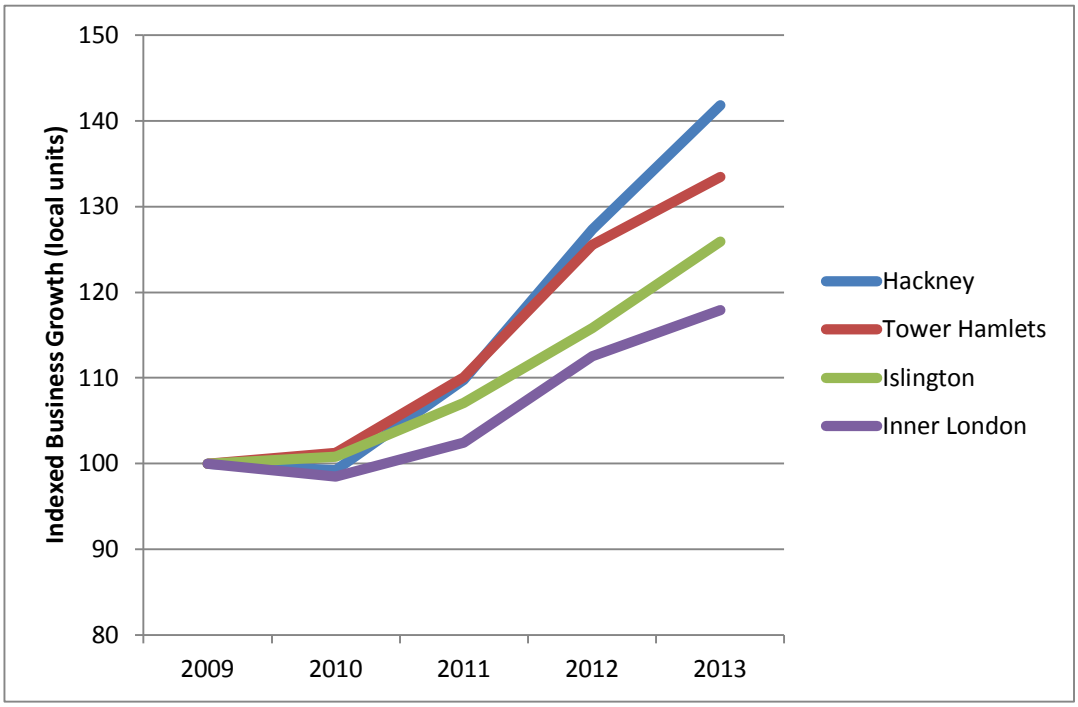
4.4.2 Exploitation - post 2010

The cluster has grown considerably in the last four years. There is a certain amount of evidence to suggest that the cluster's development since the Tech City announcement at the end of 2010 resembles the exploitation stage of the adaptive cycle model.

4.4.2.1 Accumulated Capital

In terms of resource accumulation, as Chart 3 shows, business growth in the information and communications industry group for the main three boroughs in Tech City has outpaced the rest of Inner London[2]. Hackney, which contains the Shoreditch/Hoxton area has grown by over 40% since 2010.

Chart 3 - Information and communication industry business counts by local authority 2009-2013



Source: ONS IDBR data, 2013

The cluster has also experienced employment growth, but it is the quality rather than the quantity that most participants spoke of.

> *"The cluster has become a magnet for talent"* (I14)

> *"The level of technology and skillset is getting larger (in accelerators)"* (I12)

Supporting firm growth has been an increase in productive capital as people have become aware of, and try to seize, commercial opportunities. The cluster has experienced a rapid accumulation of financial capital in the last four years. In the first quarter of 2014, London received £395m in venture capital investment, an amount not experienced since early 2001 and most was directed at digital media businesses (Manners, 2014). The range of financial capital available to tech firms at all different stages of business growth has been increasing.

[2] Reporting at a sub-local authority level proved a challenge as data access was prohibited for public users. However, local authority data is considered more accurate and reflects the geographical growth of the cluster. The information and communications industry group was chosen as it best resembles the digital content sector. The timeframe of 2009 onwards was chosen as this is when SIC 2007 codes were first reported and therefore allows consistency with identifying times series trends.

> *"The availability of angel investment has improved and the venture capital availability has also started to improve"* (14)

The Tech City area has seen a large amount of commercial property investment and growth in office space in recent times (Tech City UK, 2013). London is also now home to over 30 co-working incubators and accelerator spaces most of them located in East London (Tech City UK, 2013; CoWorkingLondon, 2014).

The knowledge capital within the cluster has also developed further. New firms and institutions are bringing a wealth of information and expertise that seems to be disseminating across the cluster.

> *"The community of knowledge is excellent, much better than it has ever been."* (Webb cited by Tech City UK, 2013, p.8)

However, this does not seem to have transferred into a greater amount of technological innovation as measured by traditional methods. The level of patent applications for the area is quite low and has actually fallen from a high of 24 in 2008 to 9 in 2012 (Carpmaels & Ransford, 2013). Most start-ups though operate by developing new business models from existing application-based technology and therefore patents are either seen as not necessary or would involve complex application procedures (I8; Carpmaels & Ransford, 2013).

The brand equity associated with cluster has increased. Tech City UK (2013) estimates that over 2,526 articles were published globally in 2013 referencing 'Tech City' and 'London', up from 147 in 2010. International delegations are now visiting the cluster to learn about and connect to what the cluster is doing (I5).

Institutional capital has been improved with the development of the TCIO and policy changes on a national and local level. This has provided the cluster with a more favourable environment for growth.

> *"With the Government's EIS* [Enterprise Investment Scheme] *and SEIS* [Seed Enterprise Investment Scheme] *it's made the UK one of the most attractive places to put in early stage investment…it has enabled people who may traditionally not have considered investing in these private entities to take the step towards that"* (I16)

This is combined with improved access to supporting professional services targeted at helping with challenges related to early stage company formation.

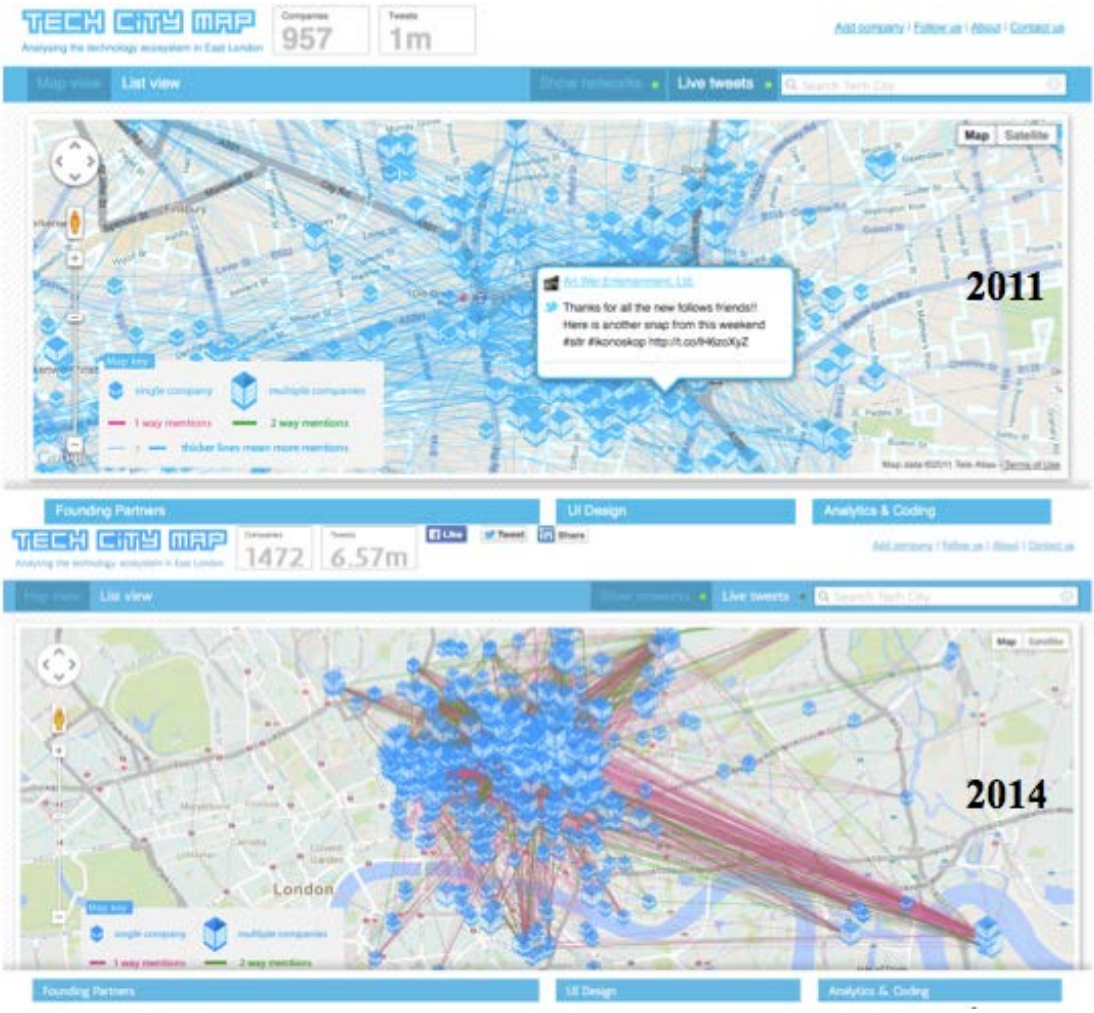
4.4.2.2 Connectedness

Connectedness has also improved with an increase in the amount and variety of internal and more importantly external links that cross the cluster's boundaries (I7). This in part has been a result of larger and more diverse networking activities.

> *"I've seen it, through the events business, probably a 10x growth in the last four years, from events being attended by 35 people, to 350 people"* (I7)

The growth of social connections within the cluster can also be seen via the increase in amount of companies and institutions referring to other agents in online tweets between 2011 and 2014 (see Figure 15). In the space of three years, Tech City Map recorded over 5 million tweets mentioning activities and events that were participated in or followed by at least two agents in the cluster (from 1 million to 6.57 million).

Figure 13 - Tech City growth in online connections



Source: Tech City Map, 2014; City Lab, 2011

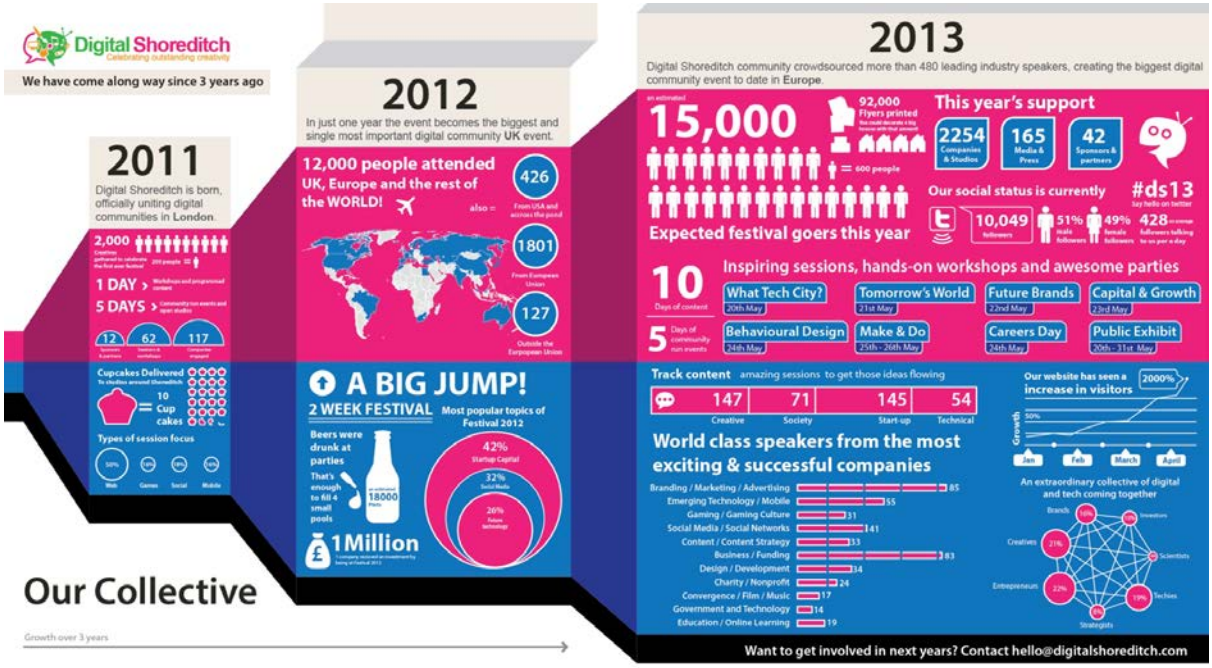
The willingness to establish partnerships based on mutual beneficial outcomes has also increased as the cluster has evolved. These may involve large corporations partnering with other organisations such as universities or accelerators. For example, Barclays who has collaborated with the Tech Stars accelerator in a co-working space in Whitechapel (I10).

> *"There seems like there is a greater appetite to commercially collaborate then there probably has ever been"* (I2)

The development of thematic niches within the cluster has allowed firms and organisations in similar fields to identify greater opportunities for collaboration (I2; I13; I14).

The range and quantity of projects and programs being initiated and delivered via partnership models has increased considerably (I1; I7). Events are also connecting a greater number and variety of individuals from more and more diverse locations. A clear example of this can be seen in an infographic produced by Digital Shoreditch tracking the growth of its festivals (Figure 16). In 2011, they had 2,000 attendees, whereas by 2013 they were expecting 15,000 from across the world.

Figure 14 - Infographic charting growth in the Digital Shoreditch Festival



Source: Digital Shoreditch, 2013

4.4.2.3 Resilience

The literature suggests resilience is still strong during the exploitation stage despite the increase in new entrants, external competition and shocks to the system generated from its rapid growth (Martin and Sunley, 2011). The East London cluster would seem to support this. Survival rates for small firms are strong (Keck and Ray, n.d.) and even with the collapse of some businesses, the ecosystem is supportive of re-entry.

> *"You are going to get some failures…but the message being put out by people (in the cluster) is – it's ok to fail, learn from it"* (I9)

In addition, despite criticism over the increasing rents and 'event overload' generated by the cluster's popularity, new firms and new talent are still being attracted. Data shows that the area between Clerkenwell and Shoreditch had the largest amount of business births of anywhere in the UK in the year 2013/14 (Grut, 2014).

However, as Martin and Sunley (2011) suggest, the resilience and adaptability of cluster is relatively unknown until it is tested by an external shock. Opinions of whether it can survive some large business losses or the next economic crisis are mixed.

> *"It is still fragile… it will only take a few expensive failures for the market to panic"* (I7)

> *"A lot of companies will go to the wall, but the cluster will probably survive (an economic downturn) because it has enough robustness"* (I11)

There is a general perception, though, that the cluster was developed in large part through small, innovating, bootstrapping firms that still exist in the cluster and would possibly benefit from any release of resources that another crisis would provide (I1; I8).

Anecdotal evidence from research participants would also suggest that the cluster has most definitely moved past the initial reorganisation stage, but has not reached maturity just yet.

> *"I think its past the toddler stage, the question is whether its reached puberty"* (I11)
>
> *"We're in its adolescence now, growth spurts are kicking in and with that comes challenges"* (I7)

It has been observed that the cluster will mature only when more individual start-ups start maturing and becoming established tech companies (I10).

4.5 Analysis of cluster – complexity leadership

The adaptive cycle model serves relatively well as a descriptive lens but it cannot fully explain what has enabled the cluster to evolve and move through the different phases. The multitude of complex forces that have helped shape the cluster over time are captured by this statement from a research participant:

> *"The work that Nesta does, the work that Shoreditch Works does, Young Rewired State, Tech Hub, Google campus had a huge impact on the area, the coffee shops that we're sat in, the local broadband, the fact that schools started to engage with the scene, the fact that the press started to pay attention…everyone was responsible for contributing something in someway"* (I7)

This research is focussed on more constructive forces that involve actions by individuals or organisations and less on exogenous evolutionary forces.

The following sub-sections will apply the model of complexity leadership theory to the analysis of agent interactions during the different phases of the cluster's evolution that were identified in section 4.4. An attempt has been made to identify relevant actions/strategies that align with the different complexity leadership functions. Strategies are coded based on the methodology in Chapter 3 and mapped to leadership functions where possible. Due to adaptive leadership being an emergent dynamic that is generated from conditions that are fostered by enabling leadership, it is sometimes hard to distinguish specific single strategies that certain actions should fall under. Therefore, some actions contain multiple complexity leadership codes.

4.5.1 Reorganisation phase

It would appear that enabling leadership played an important role during the reorganisation phase of the cluster's evolution. The summary table at the end of this section shows a count of the apparent key strategies used during this phase and emphasises the influence it played, along with adaptive leadership that is an emergent outcome of other actions (see Table 6). Administrative leadership seemingly played a minor part with very little strategic planning or coordination of resources towards the cluster's growth.

4.5.1.1 Administrative Leadership

There seems to have not been many identifiable administrative actions that were specifically aimed at planning or coordinating the cluster's growth. There is evidence of a small amount of resources allocated towards associated cluster networking and media promotion. However, most actions were not entirely collectivist in nature and a clear united vision was lacking. Digital Shoreditch, the industry led community initiative, was possibly the only coordinated effort to unite the community behind a common goal but its actions up to 2011 were limited in scope [OR] [IN].

Local governments in inner East London played some part in enabling the cluster via certain bureaucratic planning decisions. Councils like the London Borough of Hackney played a role in improving the urban environment whilst maintaining support for maintenance of flexible

creative spaces (I3). They provided general services targeted at improving safety and street amenity along with continually supporting the hosting of cultural events.

Successive governments also focussed on regenerating what were relatively deprived areas of London. In 1996, relevant inner city boroughs had established the City Fringe Partnership as a coordinated attempt to increase economic growth and social inclusion (Cities Institute, 2009). In the 2000s, a more private sector orientated approach to regeneration was adopted based on the City Growth Strategies concept developed by Porter's Initiative for a Competitive Inner City (ICIC, 2003). The initial City Growth Strategy (CGS) for the city fringe area even included initiatives targeted at specific clusters in the area, six out of nine that were related to creative industries (Bagwell, 2008 cited by Foord, 2013). The CGS was somewhat successful in mobilising the private sector to support initiatives that brought new resources and enabling policies to creative tech complementary industries such as publishing and hospitality (Cities Institute, 2009) [PR] [IN].

Some participants argued that these efforts at regenerating the area and ensuring that the creative industries were an integral part of local government visions ultimately created an environment where a creative digital cluster could prosper.

> *"That part of London, there were successive attempts to regenerate that part of London…you could argue that Silicon Roundabout is an unplanned result of that regeneration"* (I1)

However, it appears at a strategic level that no specific acknowledgement of the tech start-up cluster, or initiation of actions to support it, was made during the mid to late 2000s. For example, the Hackney Council's Core Strategy adopted in 2010 refers to a concentration of creative sector businesses and night time activity in Shoreditch but does not mention anything regarding a clustering of small technology firms (LBH, 2010)

4.5.1.2 Enabling Leadership

Arguably the most important factor in the emergence of the cluster was the adhoc use of working spaces by multiple businesses that initiated the first interactions between firms in the area (Biddulph, 2012; I5) [FI]. This shared working environment ultimately gave forth to informal socialising events between co-located businesses e.g. MiniBar, Moo BBQs and Last FM parties (Biddulph, 2012; Foord, 2013) [FI]. Formalised networking spaces were also established during this period with Shoreditch House, a branch of Soho House the self-described "private members club for those in film, media and creative industries" (Soho house, n.d., para.1) opening in 2007 (I7) [FI].

These interactive events and spaces supported the sharing of knowledge within the cluster about different technology platforms and external market trends (McKinsey, 2011) [KN]. Opportunities for commercial and informal collaborations were also identified and a number of start-ups sourced talent or funding out of conversations held at meet-ups or industry events (I5) [FD][IM] [UI] [TI] [CR].

As Uhl-Bien et al. (2007) point out, interaction alone is not sufficient for complex dynamics. The development of businesses specifically focussed on co-working spaces, such as TechHub, created a level of interdependency between system agents that pressured them to develop but also share knowledge and ideas [FD] [KN].

> *"Having people around you who are also venturing their life savings on pursuing a dream is very positive reinforcement. It also provides resources to bounce ideas around and get feedback"* (Caldwell cited by McKinsey, 2011, p.12)

The economic wellbeing of businesses were also now dependent on the success of others – start-ups relied on the cheap rent and well designed collaborative space, and the co-working businesses relied on the success of host start-ups to grow their business. This often forces businesses to adapt and co-evolve with their hosts (Sutcliffe cited by TechHub, 2014) [TE][CR].

The concentration of so many tech firms in smaller focal points within the cluster also provided an easier entry point for investors and other interested parties to connect with the cluster (McKinsey, 2011) [PR] [TI]. It is much more convenient to visit or contact a few key locations than a multiple of dispersed businesses across East London.

Towards the end of the 2000s, firms within the cluster also began to make connections with other diverse but related or supportive actors and industries [TE]. Some co-working spaces such as White Bear Yard had specific links to angel investors with international expertise (Butcher, 2011). Other events and collaborations began to appear involving not just local creative digital firms but also investors, government agencies, tech firms and agencies in other clusters (Foord, 2013; PR Web UK, 2013). This diversity helped to connect different scales and visions [CN] [FL].

A few key actors in the eco-system played an influential role throughout this period in embracing the idea of a creative digital cluster and working to attract attention to its activities [IT]. There was the initial labelling and mapping of the cluster by Matt Biddulph but a number of other people also started to champion the Silicon Roundabout name.

> *"I was banging the Silicon Roundabout drum pretty hard for a year or so of that. I'm know other people were working on this too"* (Webb, 2012, para.1)

Individuals like Richard Moross (Moo) and Michael Acton Smith (Mind Candy) who worked in the area running their own businesses and were passionate about tech start-ups were important in building early connections (Biddulph, 2012; I5; I7) [CN].

Some individuals also took the initiative to articulate the cluster's growth challenges with relevant authorities or institutions that were in position to address them [IT]. Matt Cowan who attended the trade mission that initiated government discussions around Tech City is an obvious example (I1). These people introduced the cluster's identity to new players that eventually led to an injection of resources and supportive structures [PR] [IN].

The media also contributed to cluster development by constantly referencing the Silicon Roundabout name, discussing new trends and even conducting research to clarify the identity of the cluster [IN] [SM].

4.5.1.3 Adaptive Leadership

Most of the early co-working spaces that were identified with the cluster were created through opportunistic decisions made by friends and acquaintances looking to cut costs and work with similar individuals. Some larger ones developed through the entrepreneurial actions of businesses that were trying to recoup costs from renting larger than necessary offices (Cowan, 2013; I5) [IM].

The transformation of co-working spaces from adhoc arrangements to specific businesses with associated support services was an opportunistic action that ultimately changed the perception of what was possible in the cluster [RF]. It led to an up-scaling in resources and also an increase in constructive knowledge spillovers [PR] [KN]. Places like the Trampery and Tech Hub also provided some sense of structure that fragile early-stage businesses could draw on by membership association [IN].

The original naming of the cluster might have originally been a joke but it offered an identity that businesses in the area could understand [SM] [IN]. Silicon Roundabout caught on as a brand and gained a certain amount of traction as the years progressed (Biddulph, 2012) [KN]. Biddulph drew a map of known start-ups and agencies in the Shoreditch area to accompany the initial media articles. The original list contained 15 companies but in subsequent months, numerous businesses looked to self-identify with the emergent 'cluster' leading to further published maps and associated articles that helped to establish its geography and scope (I1) [SM]. In this way the media played a large supporting role in growing the brand and helping to clarify its identity [SM]. As activities and agents connected to the brand, people started to generate new ideas of what was possible with a more connected and developed ecosystem [RF].

> *"if we could "ignite" the area, then there would be more people, more services, more good chats, more community, etc"* (Webb, 2012, para.9)

This increase in ambition targeted at a community rather than just a firm seemingly attracted new firms to the area and drove an increase in opportunistic activities [CR].

Coinciding with the establishment of an identity for the area was the adoption of new terminology to describe the firms that operated there [SM] [UI]. 'Creative tech' became a catch–all for any firm in the area who was combining the use of technology, mainly digital media, in a creative way. With the rise of social media and web based applications, many media agencies started calling themselves 'digital agencies' to reference the fact that most of their work was done in the digital space (I8). 'Tech start-ups', or simply 'start-ups', was commonly used to refer to new businesses with low amounts of employees but relatively high growth business models based around digital platforms. The terms 'bootstrapping' and 'shoe-string budgeted entrepreneurs' were used in reference to the very low capital base that start-ups came from with many self-financing their early growth (I16). Many of these terms weren't common references even five years prior.

> *"Back then you never said, we never said we were a start-up, we never said we were entrepreneurs"* (I8)

Later on, some people became 'tags' for the system, representing the community and speaking on its behalf. Lichtenstein and Plowman (2009) suggest when individuals accept this role there is a greater chance of emergent self-organisation. The founders of co-working spaces such as Elizabeth Varley and Mike Butcher (Tech Hub) often embraced their position as hubs or focal points for connecting businesses and resources (finance, talent) in the area (I9) [SM] [CN] [TI] [UI]. Butcher in particular used his extensive media connections as Editor of TechCrunch magazine to create publicity around the cluster's activities (Foord, 2013) [KN]. Actions by angel investors such as Stefan Glaenzer were equally important in attracting the attention of other early stage financers (Cutler, 2009) [PR].

Table 6 - Frequency distribution of leadership strategies

Leadership Function	Strategy	Examples	Counts of action types [3]	Adaptive dimensions supported
Administrative Leadership	Orientating [OR]	Digital Shoreditch collective	1	[IN]
	Coordinating [CO]	Regeneration efforts e.g. City Growth Strategy	1	[PR]
	Directing [DI]	Regeneration efforts e.g. City Growth Strategy	1	[IN]
Adaptive Leadership	Improvising [IM]	Ad-hoc sharing of resources; identifying new collaborative opportunities	2	[FL]; [CR]
	Reframing [RF]	Turning co-working spaces into new business models; rethinking the possibilities of the ecosystem	2	[PR]; [KN]; [IN]; [CR]
	Sensemaking [SM]	Coining 'Silicon Roundabout'; Using common language e.g. start-ups; Mapping of firms; People embracing 'tag' roles; Researching to aid cluster identity	5	[KN]; [IN]; [TI]; [UI]
	Connecting [CN]	Linking tech advances with existing businesses e.g. media and apps	3	[TI]; [UI]
Enabling Leadership	Fostering interaction [FI]	Informal co-working spaces; Formalised co-working spaces; Networking events	3	[KN]; [UI]; [TI]; [CR]
	Fostering interdependence [FD]	Co-working space memberships; collaborations	2	[CR]; [FL]; [PR]
	Injecting tension [TE]	Bringing in other organisations e.g. investors, government, media; Concentrated co-working hubs	2	[FL]; [KN]
	Integrating [IT]	Individuals promoting Silicon Roundabout; Challenges being raised with Government; Media promotion and discussions	3	[PR]; [IN]

[3] Counts are only a representation of identified types of action within each strategy area. They may have been multiple examples of actions within each type. For example, there were multiple informal networking events.

4.5.2 Exploitation phase

Using complexity leadership theory to analyse the exploitation stage of the cluster suggests that a more diverse range of strategies were involved in enabling growth than in the reorganisation stage. As the summary table at the end of this section shows, administrative leadership played a much more influential role (see Table 8).

4.5.2.1 Administrative Leadership

As Uhl-Bien (2007) note, administrative leadership in CLT is a matter of playing a coordinating role but with consideration of the importance of not stifling creativity and innovation. In the East London cluster, there was early criticism of the Tech City brand (Solon, 2012a) and there have been some situations where governments have been accused of picking winners (Pickford, 2013) or in creating a tech boom that is actually destroying creativity by forcing start-ups out of Shoreditch (Doctorow, 2014). However, for the most part, governments and cluster-focussed organisations have played a more facilitative rather than directive role.

The various levels of government and in particular the TCIO were the most important actors involved with building a more ambitious vision for the cluster [OR]. The vision for a 'Tech City' seems to have coalesced various fragments of the cluster and been bought into by enough actors that even some people who were working there in the mid-2000s seem now relatively comfortable associating with it (Nathan et al, 2012). The TCIO initiative itself was led by entrepreneurs and interested members of the private sector who were interested in "creating a central voice for the disparate parts of the cluster" (I14). The vision and work of the TCIO created not only a more marketable brand but also an entry point that perhaps hadn't existed previously for corporates, large organisations, institutional investors and overseas governments into a rather complex embryonic group of businesses (I7) [KN][PR].

The TCIO has also been involved in monitoring the cluster's growth and evaluating the effect of different initiatives via the release of regular annual reports (TCIO, 2012; Tech City UK, 2013) These reports provide an insight into the scale of the cluster and its activities, albeit one that is heavily influenced by TCIO's promotional interests. However, they do involve input from various stakeholders and therefore do contribute to identification and understanding of what the cluster encapsulates [SM] [IN].

Policies enacted by central government have also directly contributed to creating a more favourable institutional environment [DI] [IN]. Specific policy changes were aimed at addressing some of the constraints faced by the cluster (See Table 7.) For example, many participants see a direct link between the central government's taxation policy changes and the growth of capital in the cluster in the last 3-4 years (I16) [PR]. A range of other policies and programmes has helped create new opportunities for tech-based companies. These include establishing a more open procurement framework for digital services via G-cloud and launching the Open Data Institute that aims to make public data more accessible and thus support data based businesses (Tech City UK, 2013) [IN].

Table 7 - Supportive policy changes

Policy Change	Details
Entrepreneurs' Visa (First drafted 2008)	Allows overseas entrepreneurs to come to the UK to start, extend or take over a business.
R&D Tax Credits	Increased to 225% for companies with fewer than 500 employees
Entrepreneurs' Relief	Doubling the lifetime limit on capital gains qualifying for entrepreneurs' relief (10% capital gains tax) to £10 million
Enterprise Investment Scheme (EIS)	30% income tax relief for private investors
Seed Enterprise Investment Scheme (SEIS)	50% income tax relief for UK taxpayers investing in qualifying start-ups for the first £100,000 seed investment
Enterprise Management Incentives Schemes (EMIs)	Allowing individuals acquiring shares under these employee share schemes to more easily access Entrepreneurs' Relief
Patent Box Scheme	Lowers Corporation Tax to 10% on profits from the development and exploitation of patents and other intellectual property

Source: Tech City UK, 2014a; HM Revenue & Customs, 2014

Policies have been supported with the direct allocation of funds towards programs and competitive grants aimed at helping start-ups as well as more advanced tech companies [CO] [PR]. In 2011, the Technology Strategy Board (TSB) developed the Launch Pad, a cluster development tool in the form of a competition where young, early-stage tech companies could make a pitch for £100,000 of funding on a like-for-like basis. The initial fund proved to be overwhelmingly popular and has since been adapted for other tech-based clusters in the UK (I11). As one of the administrators of the fund recalls:

> *"We set aside one million originally…we were so oversubscribed that we doubled the pot"* (I11)

The TSB also established a programme called 'IC tomorrow', which is based in Shoreditch and funds competitions, events and mentoring programmes to support start-ups, initially in Tech City but now across the UK (TSB, 2013; I11). On the investment side, the UK Government has invested £25 million into Passion Capital, an early stage venture capital fund based in Clerkenwell (Butcher, 2011).

The Greater London Authority (GLA), the city government, has often worked in partnership with central government to develop the cluster. In 2013, they launched the 'Smart London Plan', a visionary document that outlines programs and infrastructure designed to turn London into a leading centre for digital technology and innovation (GLA, 2013) [DI] [CO]. Funded initiatives such as Tech City Stars, a programme for youth in the Tech City boroughs, and the Super Connected City Plan aimed at improving digital infrastructure in Tech City are also boosting productive capital in the area (GLA, 2013; Shaffi, 2012) [PR].

Local governments have also been involved with cluster development through collaborative partnerships, consultation and enacting enabling policy. The Hackney Council commissioned a review to look at ways to leverage opportunities stemming from Tech City for the wider community and to ensure its growth does not come at the expense of local resident's livelihoods [DI] (LBH, 2014). They have worked with developers and commercial enterprises to manage supply of workspace for start-ups and ensure the maintenance of the area's creative environment (Keck and Ray, n.d.; I3) [PR] [CR]. The council have also directly invested funds to support cluster-enabling activities, such as with the establishment of Bl-nk, a combined networking, investment and artistic space in Shoreditch (Sterling, n.d.) [CO].

4.5.2.2 Enabling Leadership

One of the key enablers of cluster growth in the period after 2010 has been the increase in the range of support mechanisms for tech start-ups via the establishment of accelerators and incubators. These organisations such as Tech Hub are not only providing necessary financial and workspace resources but helping to foster collaborative arrangements that live on past the program end dates (I8; I10; I13) [FI] [FD] [PR] [TI]. They also provide participants with strong experiential knowledge that drives them to be ambitious and look for up-scaling opportunities [KN] [IM] [CR]. There has been an increase in these more advanced co-working spaces in recent years and also in specialist incubators focussed on specific markets (e.g. ed-tech).

Porter (1998a) describes clusters as interconnected companies and institutions. Therefore it can be argued that Tech City has only just emerged as a real cluster as non-firm based organisations are now acknowledging and connecting to the localised specialisation. In Tech City this has come in the form of commercial partnerships such as IDEALondon, an innovation focused start-up incubator run by Cisco, DC Thomson and University College London (UCL, 2013) [FD] [CN] [TI]. Collaborative community focussed initiatives are also emerging such as the Centre for London's Connecting Tech City campaign which is backed by private and public sector agents and is targeted at aiding disadvantaged East London youth access opportunities in the cluster (Keeley, 2014) [FD] [UI]. Other partnerships are directly targeting resource challenges within the cluster, such as the Tech City Apprenticeship scheme run by Hackney Community College in collaboration with a variety of government and private sector stakeholders which is aimed at offering youth workplace opportunities with tech companies in the area (HCC, 2012). [FD][CN][UI][TI]

A key enabling leadership strategy is generating conditions where individuals within a system can influence policies and the allocation of resources that support its adaptability (Uhl-Bien, 2007). Tech City breakfasts at No. 10 and initiatives like the London Tech Ambassadors Group are mechanisms that have allowed this bottom-up feedback to occur [IT]. It was via these means that the ecosystem was able to raise issues related to broadband infrastructure and high-skilled visas (Solon, 2012a) [IN]. The cluster's connection to media platforms such as Tech City News and Tech Crunch, also provide outlets for discussing challenges to cluster growth. This exposure often attracts firms who generate new business models to seize opportunities [IM]. For example, the Makers Academy, which is dealing with short-term talent constraints by running intensive coding or software design programs that feed graduates straight into companies that need their skillset (du Preez, 2013).

The dynamics of the cluster have changed with the arrival of a number of the multi-national IT firms and foreign investors [TE]. In recent years, Google, Intel, Microsoft, IBM and Cisco have all made some level of investment in Tech City. VCs and angel investors from aboard are also now looking for new opportunities in the UK market.

> *"The valley* [Silicon] *is now starting to come over to London and once that happens, they're used to doing napkin raises and seed round raises very quickly and that'll change the dynamics"* (I12)

The influx of larger companies and overseas entrepreneurs has generated a level of tension and sense of urgency amongst local actors that is driving innovation [CR].

There has been some scepticism over the introduction of larger tech players to the scene and questions regarding their motives, for example whether they are just looking to identify firms to acquire in order to absorb the talent or technology. However, it appears the international exposure generated from big brand names such as Google can aid the cluster by enhancing the cluster's brand and attracting investors and tech talent [KN] [PR].

> *"If Google and Facebook start buying more start-ups here, I think that's only a good thing… even if it's an acqui-hire[4] of a team with strong engineering skills, that's still positive"* (I10)

As Tech City has grown, more and more individuals and organisations have taken up advocacy roles for the cluster [IT]. Some are formalised positions such as the TCIO CEO where promotion and support is part of the remit, but even then some high profile candidates such as ex-Facebook executive Joanna Shields have made the choice to step away from more lucrative commercial positions.

> *"Shields was called at Facebook by headhunters asking whether she could recommend anyone for the role. To their surprise, she said: 'Yes. Me.'"* (Silver, 2012, para.5)

Local governments have also championed the cluster and worked to integrate its development into higher authority plans and private sector objectives (I5) [IT].

> *"In terms of hand to hand combats and support for local start-ups, Hackney council is really activist and really good…the council has been really instrumental in helping the cluster at a grass roots level"* (I5)

In addition to advocacy, many individuals are taking on different network leadership roles in the cluster [IT]. Some people are performing the role of what Schreiber and Carley (2008) describe as 'organisational minorities', bringing new or advanced knowledge to the cluster than what existed previously, for example Saul Klein with his VC expertise (I14) [KN]. Others are acting as 'boundary spanners', linking the internal system with external networks via their extensive connections, for example Russ Shaw via the Tech London Advocates [CN]. The cluster is also still producing identifiable 'tags' and an extensive range of mentoring programs for start-ups, where people with particular expertise can pass on their knowledge (I16).

4.5.2.3 Adaptive Leadership

Uhl-Bien et al. (2007) talk of multi-level adaptive leadership where adaptive outcomes differ across different levels of a system. The entrepreneurs within this cluster tend to be quite innovative and there is evidence to support their use of digital technology to disrupt existing markets. For example, TransferWise which offers an alternative to standard banking platforms for global money transfers (O'Hear, 2014). However, during the exploitation stage other more slow moving organisations have also proved willing to adjust established patterns of operation in order to connect with the cluster.

> *"What I think is really encouraging over the past five years is the interest from big corporates to collaborate with start-ups, there's a real interest and even a realisation that these big companies can't move as quickly as these start-ups. The start-ups are more dynamic and can be a source of innovation for big companies…they are looking for new solutions so they don't become irrelevant, just keeping abreast of what is happening in the market"* (I16)

Large companies are seeing the potential opportunities that commercial backing of incubators may provide [IM] [CR]. For example, Unilever and John Lewis, a UK department store, are funding tech start-ups and offering them the opportunity to trial their technology in established consumer networks (Vizard, 2014). Start-ups benefit from an injection of capital and access to established markets [PR].

[4] An acqui-hire is the acquisition of a smaller company by a large firm in order to gain access to their employees

Professional services firms, governments and higher education institutions have also adapted their programs and products to support the start-up scene as they have identified opportunities (I3; I15). Many financial and legal firms are providing flexible fee structures and new products to support the growth of start-ups [IM] [CR]. Some such as KPMG have even established presences in Shoreditch, the heart of Tech City, which falls outside traditional business services locations (KPMG, 2014). Governments are leveraging the growth of the cluster to support community goals or political objectives [IM] [CR]. Universities have also established their own incubators in informal co-working settings to support students and alumni development of new businesses (Baldwin, 2013; I8).

The Tech City initiative itself was an opportunistic decision to latch on to a source of innovative new growth in a relatively underdeveloped area of inner London (I1; I7). The work of Rohan Silva and other advisors to the PM in drafting a policy platform that substantially up-scaled the potential for the cluster area cannot be understated (I14) [RF]. The enactment of this platform by the TCIO and others contributed largely to the accumulation in resources and growth in connections seen post-2010 (I5; I7) [PR] [KN] [IN] [UI] [TI].

Seizing the opportunities that hosting the Olympics in 2012 provided was an important catalyst for cluster growth (I3; I14) [IM]. It provided a large amount of potential post-event development space for the Government's tech city vision [PR]. A competitive bidding process was even held to select a developer to transform the media and broadcast centre into a new large scale mixed use creative and digital technology hub (BBC, 2013). It also offered the opportunity for many actors to showcase the talent and expertise of the cluster to an international audience [KN]. Hackney Council, an East London local authority, opened 'Hackney House' in 2012 as an Olympic Games digital media centre and an inward investment mechanism to market the area's creative and tech industries. As a councillor recalls:

> *"Hackney House, the pop up hackney house, that came out of 2012, we deliberately used 2012 as that catalyst."* (I3)

TCIO even ran a 'Start-up Games' where international participants pitched business ideas to potential investors and at the same time organisers were trying to market the benefits of East London to the start-ups (METRO, 2012).

One of the largest impacts on the local scene has been via Google launching its first start-up hub 'Google Campus' in Shoreditch in 2012. They amplified the concept of an incubator by partnering with TechHub, SeedCamp and Central Working (a members based freelancers club) to redevelop a seven storey site into a start-up factory that offers a variety of working spaces, event space and accelerators [RF]. The 'Campus' has helped generate creative tension by housing so many start-ups and support organisations in one building and by offering most of its non-accelerator space for free [TE] [CR].

> *"There was no such space before in London, free space, stylish, with high speed internet connection, paid by Google with the branding of Google with their security where you can meet all the entrepreneurs, all the officials from government, all the techies"* (I4)

Social industry networking during this period was transformed from after-work BBQs to bigger and more formalised networking events [RF]. Event companies such as the 3Beards began to organise weekly (Silicon Drinkabout[5]) and monthly (Don't Pitch Me, Bro!) events that were held in larger spaces and brought in a more diverse range of interested actors (I7; I9) [FL].

[5] Originally founded by Mind Candy

> *"We'd been to networking events and they were shit. So we thought, let's just do it better"* (I7)

Other organisations such as Silicon Milkroundabout, which runs a tech start-up job fair, began to host events that specifically focused on building enabling linkages within the system to deal with resource constraints (I9; I16) [PR] [TI].

The cluster also began to structure networks around specific focus areas and establish links nationally and internationally [CN] [FI]. For example, Tech London Advocates, a private sector advocacy group for the London Tech sector, has recently developed specific working groups aimed at addressing challenges or enabling opportunities in specific areas such as promoting women in tech (I6) [IN] [PR]. The group has also received considerable interest from overseas actors:

> *"they're very interested in London, why is tech taking off in London…we've got a lot of Swedes…folks in Johannesburg, in Lagos, in Seoul who are interested in just connecting and seeing and understanding, some are talking about creating similar types of groups, others are just saying how do we connect in with what you're doing"* (I6)

Landmark events have also played a role in building international exposure and connecting the cluster externally [CN] [IN]. Events such as the Digital Shoreditch Festivals and the 2014 London Technology Week were widely promoted and brought together a range of partners to host connected activities that attracted national and international attendees.

The cluster continues to produce individuals who unofficially act as role models or identifiable symbols of the cluster and its various agents [SM]. Guardian (2013) even ran an article showcasing the entrepreneurial who's who of Tech City (Figure 17).

Figure 15 - The Guardian's who's who of Tech City

Source: The Guardian, 2013

These people reinforce brand identity and help to institutionalise cluster norms and values [IN]. The Mayor of London has also announced a London Tech Ambassadors Group in 2014 consisting of a number of actors from the cluster (London & Partners, 2014).

The media has continued to report on the cluster, often discussing challenges to its growth and negative impacts as well as its many achievements. In this way it offers a chance for agents to consider the cluster's evolving identity and identify future pathways [SM][IN]. Media attention

has also played a strong role in gaining wider attention for the cluster in national and international forums (I7; I8) [KN].

Table 8 - Frequency distribution of leadership strategies

Leadership Function	Strategy	Examples	Count s of action types[6]	Adaptive dimensions supported
Administrative Leadership	Orientating [OR]	Tech City Vision; TCIO monitoring and reporting; Smart London Plan	3	[PR]; [KN]; [IN]
	Coordinating [CO]	The Launch Pad competition; VC fund investment; Bl-nk creative and investment space	5	[PR]; [CR]
	Directing [DI]	Investment policy changes e.g. SEED; Opening of government procurement	4	[IN]; [CR]
Adaptive Leadership	Improvising [IM]	Commercial and university backed incubators; Olympics leveraging; Professional services adaptation of products	5	[PR]; [FL]
	Reframing [RF]	Tech City Vision; Google Campus	2	[KN]; [IN]; [PR]; [TI]; [UI]
	Sensemaking [SM]	Tech City Ambassadors; Media analysis	3	[IN]
	Connecting [CN]	Boundary spanners; Landmark Events	2	[IN]; [PR]; [KN]
Enabling Leadership	Fostering interaction [FI]	Accelerators and Incubators; Large scale networking events	2	[PR]; [UI]; [TI]; [UI]
	Fostering interdependence [FD]	Accelerators and Incubators; Commercial partnerships; Community collaborations;	4	[KN]; [IN]; [PR]; [TI]; [UI]
	Injecting tension [TE]	Influx of overseas investors and entrepreneurs; Google Campus	2	[KN]; [PR]
	Integrating [IT]	No. 10 Tech Breakfasts; London Tech Ambassadors; Local government championing	3	[IN]; [CN]

[6] Counts are only a representation of identified types of action within each strategy area. They may have been multiple examples of actions within each type. For example, there were multiple incubators and accelerators.

4.6 Complexity leadership in different adaptive cycle phases

This section compares the role of different complexity leadership functions in the two phases of reorganisation and exploitation and seeks to identify key actions that induced the transition between them. It also provides some comments on the difficulty in identifying specific defined leadership actions due to the complexity of a cluster.

4.6.1 Reorganisation vs exploitation

The triangulation of interview participant opinions, secondary data analysis and frequency counts of types of leadership strategies (section 4.5) confirm the greater role administrative leadership played in the exploitation phase compared to the reorganisation phase. It also affirms that enabling leadership was very important throughout both phases and that adaptive leadership outcomes have increased as the cluster has grown.

There is the perception that the early development of the cluster was quite organic with little direct strategic planning (Wendling, 2011; Biddulph, 2013; Nathan et al., 2012; Ranger, 2014; I1; I3; I5). If strategies were adopted that enabled a cluster to form, it was more about creating better working relationships rather than having a plan for the local ecosystem.

> *"Well I don't know that there were actions being taken so much as just stuff getting done. There was cheap infrastructure, there were lots of people with great ideas and a lot of socialising within that. It was quite a tight knit community at that time…I don't think actions being taken were a part of it, we happened to gather here"* (I5)

Whether purposive or not, people's choices to create spaces and events that enabled informal networking are highlighted as being most important to the cluster forming during this period (Biddulph, 2012; I5; I7; I9)

The other important enabling strategy during reorganisation was for a few key individuals in the cluster to champion the concept of Silicon Roundabout. A group of people commonly appear in research participants' accounts and media articles of that time as being important integrators of knowledge and networks within the cluster (Biddulph, 2012; Foord, 2013; GrowthBusiness, 2011; I5; I9). These include Matt Webb (Berg), Richard Moross (Moo), Michael Acton Smith (Mind Candy), Christian Alhert (MiniBar), Mike Butcher (TechCrunch), Elizabeth Varley (TechHub) and Charles Armstrong (The Trampery).

Post-2010 the more administrative influence of governments is evident and opinions on their efforts are mixed. They have been criticised for latching on to the cluster's success and not doing enough to deal with real infrastructure and policy constraints (Solon, 2012a; Nathan et al, 2012; Donovan, 2014). They have also been labelled as destroyers of the cluster's original identity by favouring bigger companies and property developers over start-ups (Doctorow, 2014; Foord, 2013; Brown, 2012).

However, the general perception amongst research participants is that they have performed a role that resembles Uhl-Bien et al.'s (2007) description of administrative leadership - exerting influence and authority but with a certain consideration of the cluster's need for adaptability. They have served a facilitative role rather than being too directive (Keck and Ray, n.d; I2; I7; I9; I14; I15).

> *"I think what's fascinating to me is I don't think they did give it any structure, I think what they did, which is the cleverest thing they could possibly do, was to let it be and just show people that it existed."* (I2)

Even the development of the TCIO is to a certain extant seen as a product of the cluster's internal actors, rather than a top down approach to cluster management.

> *"The reality is, the natural organic growth asked for an organisation like that to be set up. The key actors and people were going to no.10 and saying you should focus on this, you should help this."* (I7)

There is a general consensus that multiple governments' backing of a vision for East London as a technology centre was what increased the cluster's legitimacy and exposure in international markets (Ranger, 2014; Keck and Ray, n.d.; I1; I2; I4; I5; I7; I8; I9; I10; I11; I16). Efforts by local governments are also considered to have helped to manage some of the challenges due to growth and expansion of the cluster (I1; I3; I5).

There is also the perception that a more administrative influence was necessary for the cluster to advance beyond general organic networking and localised knowledge sharing. As evidenced by mapping of administrative leadership strategies to adaptive dimensions, these actions created a more supportive external institutional environment which was not only necessary for further growth but also being called for by local actors (Webb, 2012; I1; I7).

Enabling leadership continued to play a strong part in growing the cluster internally and externally during the exploitation phase. However, these actions appear to have been more strategic and targeted than the spontaneous and unplanned actions that occurred during the reorganisation phase.

> *"People still want to be serendipitous. We often say we can't manufacture serendipity, but we can create a space where it is more able to happen."* (Elizabeth Varley, co-founder TechHub, cited by GrowthBusiness, 2011, para.16)

Decisions by firms and institutions to connect to the cluster or run cluster events look to be motivated more by the identification of commercial opportunities than they were in the past (I7; I10; I15; I16). Regardless of their motivation, these actions also provided a more favourable internal institutional setting for the cluster (I9; I14).

Key individuals continued to play an integrating role during this phase but these positions were slightly more formalised. Specific individuals were now asked to offer feedback and ideas via exclusive meetings with central government or invited to take up ambassador roles for the city (Solon, 2012a; London & Partners, 2014; I9).

A somewhat consistent enabling force throughout most of the cluster's evolution since 2008 has been the media. Different magazines and newspapers have regularly researched and reported on the cluster's changing identity as well as discussing its growth opportunities and constraints. This appears to have allowed cluster agents and external observers to better make sense of its development and identify avenues to connect or support (Webb, 2012; I7; I9).

As the exploitation phase has developed, the boundary between administrative and enabling leadership has blurred. Many actions and events involve collaboration by a large amount of different actors and therefore necessitate a certain amount of coordination and direction. For example, Tech City UK lists over 70 different organisations from government, the private sector, local community and education as its partners (Tech City UK, 2014b) Another example is Centre for London's Connecting Tech City project that is described as "a collaboration of tech firms, Digital Learning Programmes, schools and public sector organisations" and is funded by various different methods (Centre For London, 2014, para.5). These bodies and initiatives usually have clear objectives and plans targeted at shaping the cluster but they are managed in ways that foster interdependency and sharing of ideas between partners.

4.6.2 Tipping points and transition

A number of key events or actions stand out as having been pivotal points in the cluster's evolution and some may have advanced the transition from reorganisation to exploitation.

The initial naming and self-identification of firms with the term Silicon Roundabout appears to be a key adaptive leadership outcome in the reorganisation phase (I1; I3; I5; I7)

> *"The way I see it is you've got lots of different places that were all vibrating but until you give it a name, people are just vibrating themselves, when you give it a name, people suddenly feel like they're part of something, so they start trying to vibrate together"* (I1)

The story about Matt Biddulph's text and subsequent mapping of tech firms in the area is often recounted when discussing the cluster's emergence (Wired UK Staff, 2010; Biddulph, 2012; Butcher, 2013; Cowan, 2013; Foord, 2013; Hiyalife, 2014a). What appears to be just as important is the willingness of the media at the time to latch on to the story and subsequently help shape the identity of the cluster further with follow-ups articles and reports (I1; I7).

The role of dedicated networking spaces and tech co-working hubs are also considered to be pivotal elements in the clusters early stage growth.

> *"The cluster has existed probably since Shoreditch House put down roots in the Tea Building"* (I7)

> *"I think Tech Hub was for me the tipping point"* (I8)

The opening of The Trampery and Tech Hub brought a diverse range of start-ups keen to share ideas and foster a tech community together in concentrated locations boosting the knowledge spill-over effects within the cluster (Neate, 2013; Butcher, 2013; Hiyalife, 2014b).

The most important point in time that seems to have been influential in transitioning the cluster between phases was the meeting between Matt Webb and the UK Prime Minister's advisor Rohan Silva on the trade mission to India in August 2010 (Silver, 2011; Biddulph, 2012; Webb, 2012; Wood, 2013; Butcher, 2013; I1; I8; I14). The success of the meeting was a result of both Silva arguing to get some small high growth firms on the trade mission and also Webb taking the initiative to approach Silva and discuss the cluster (Wood, 2013). This seems to be a clear example of enabling leadership, specifically the two-way integration of ideas between an administrative body and the local business community.

The direct result of this discussion and further enabling consultative meetings between Silva and the community over the next four months was the Prime Minister's Tech City announcement in November 2011. This announcement and the actions behind it were a specific adaptive leadership outcome that reframed the cluster at a larger geographical and commercial level (Silver, 2011; Biddulph, 2012; Butcher, 2013; I1; I8; I9; I14). The setting up of the TCIO in April 2011 by UK Trade and Investment was an important step in implementation of the strategies and policies within the Tech City initiative (I14; I15; I16; DBIS, 2012).

The opening of Google Campus in March 2012 is arguably one of the most significant moments in the exploitation phase thus far (I1; I4; I7; Hiyalife, 2014c). The development of a seven-storey start-up hub in Shoreditch backed by a globally recognised brand put the cluster on the radar of individuals and organisations who may not have been aware of its presence before. This is an adaptive leadership outcome as Google seems to have heeded advice from local stakeholders and made a concerted effort to integrate with the cluster and encourage a certain amount of flexibility in its operations rather than trying to just take over other firms (Dowson, 2013; I4).

The setting up and relocation of internationally known accelerator programs in the area such as Tech Stars also contributed greatly to bringing attention to the cluster (I10; I13; I16). In addition these programs brought a range of supporting financial and knowledge based resources that had not been in the cluster previously. They represent enabling leadership actions that generated adaptive outcomes such as the identification of new commercial opportunities and connections between scales.

The hosting of large tech-based events and leveraging of other national and international events also appears to have provided moments of exposure and networking intensity that amplified the cluster. These include the Digital Shoreditch Festivals (2011, 2012, 2013), London Technology Week (2014) and connected activities associated with the London Olympics (2012) (Foord, 2013; I3, I14, I16). These events represent a combination of administrative (planning and resource allocation) and enabling (fostering interaction and integrating ideas) actions.

Table 9 provides a chronological overview of the change in characteristics of complexity leadership strategies across phases and some of the key actions that mark the evolution of the cluster. It also highlights causal links between complexity leadership functions over the course of the cluster's evolution.

4.6.3 Leadership complexity within the cluster

Assigning actions to separate leadership strategies that fall clearly within the three different leadership functional areas has proved difficult when analysing this cluster's evolution. As already suggested, some actions can be described under multiple areas. For example, Hackney Councils investment in Bl-nk could be seen as an allocation of resources to support cluster dynamics (administrative) but is also clearly an attempt to foster more interaction between agents (enabling).

Identifying specific agents who were responsible for actions is also a challenge. As the cluster developed, more and more decisions were made in consultation or collaboration with multiple parties. For example, Google Campus launching in Tech City is a direct action by Google but was heavily influenced by government support and also involves strategic decisions by other incubators to partner with Google.

This appears to support Uhl-bien et al.'s (2007) description of complexity leadership functions being 'entangled within and across people and actions.' (p.306). CLT also acknowledges that there is still a place for individual leaders within system dynamics (Uhl-Bien et al., 2007). This seems to be true in this case as certain individuals clearly proved particularly adept in managing the complex interactions and information flows that the cluster generated.

Table 9 - Key actions, characteristics and influence of complexity leadership across the evolution of the cluster

Adaptive Cycle Phases	Key Actions	Characteristics of complexity leadership actions	Influence of complexity leadership functions on evolution
Reorganisation: 2002-2010	2002-2008 – Relocation of digital agency spin-offs and small creative tech firms to the area 2006 – MiniBar starts running social meetups 2007/2008 – Last.FM and Moo host regular rooftop BBQs 2008 (July) – Matt Biddulph coins term 'Silicon Roundabout' 2008 (July) – Financial Times and Evening Standard run articles referencing name and initial map 2009 – Attempts to investigate firms operating in area by Moo and Wired Magazine 2009 – The Trampery opens 2010 (January) – WIRED Magazine runs a special edition on the cluster with a new map 2010 (July) – Tech Hub opens	Limited conversations and consultation between authorities and cluster representatives Heavy emphasis on fostering interactions between firms and individuals in the area Networking is relatively informal Co-working spaces mostly result of adhoc decisions Brand identity is colloquial and localised Cluster representatives are generally self-chosen	Organic clustering of associated firms in inner East London leads to – Initial enabling leadership actions such as co-working and informal networking which leads to – The adaptive leadership outcome of the naming of the cluster and identification of initial cluster agents which leads to – An increase in enabling actions such as the creation of dedicated co-working hubs and networking places; championing of the cluster in different circles; and an increase in new firms and individuals that increases diversity which leads to – More adaptive outcomes including a growing sense of cluster identity; development of common language; creation of new business models; and the acceptance by some people of their role as 'tags'.
Transition Point: Second half of 2010	2010 (August) – Matt Webb discusses the cluster with Rohan Silva at a trade mission 2010 (last quarter) – Meetings held between cluster stakeholders and No.10 and an initiative is formulated 2010 (November) – UK PM David Cameron announces Tech City initiative	Emerging integrative communication between cluster and authorities	The enabling leadership actions of a 'tag' and an external administrative representative leads to – The adaptive leadership outcome of a reframing of the cluster's potential.
Exploitation: 2010-2014	2011 (April) – UKTI set up TCIO 2011 (May) – 1st Digital Shoreditch Festival 2011 (May) – 1st Silicon Drinkabout 2011 (May) – Seedcamp start-up accelerator relocates to Shoreditch 2011 (November) – Tech City Map launched	Rebranding that involves up-scaling of geographical and commercial scope of cluster Greater level of two-way feedback between cluster agents and administrative authorities Willingness to adapt policies to support cluster's growth	The reframing of the cluster leads to a combination of: Administrative actions such as the setting up of a dedicated cluster body, the organisation of a focused cluster event, and the launch of a start-up funding program;

	2011 (November) – 1st Tech City Breakfast at No.10 2012 (March) – Google Campus opens 2012 (June) – 2nd Digital Shoreditch Festival 2012 (July/August) – London Olympics leveraged for cluster e.g. Hackney House 2013 (February) –TechStars accelerator sets up its first base outside the U.S. 2013 (May) – 3rd Digital Shoreditch Festival 2013 (December) – Cisco led incubator ideaLondon opens 2014 (June) – London Technology Week	Greater willingness of supporting firms and institutions to adapt products and processes to connect with the cluster. Larger networking events that are better organised and attract a more diverse range of participants Better resourced and well supported start-up hubs (incubators) with associated programs (accelerators) An increase in the identification of potential crossover collaborations between cluster agents Greater identification of role model cluster agents and institutions	More purposeful enabling leadership actions such as targeted networking events, consultation meetings between different agents; and More adaptive outcomes including the relocation of an influential accelerator, the introduction of big tech brands to the area and the leveraging of an international event. This in turn leads to: Further administrative actions including policy changes and allocated investment for infrastructure; Additional enabling actions including collaborative partnerships and community programs; and Extra adaptive outcomes such as organisations adapting products and processes to connect with the cluster and the development of new cluster niches.

Source: Based on analysis of all interview participants comments and secondary data material.

Chapter 5: Conclusions and recommendations

This thesis set out to explore the role of complexity leadership in contributing to the development of a creative digital cluster in East London. The assumption was made that the cluster approximated a complex adaptive system and therefore the cluster's development would resemble certain phases of an adaptive cycle model. Complexity leadership theory was then adopted as an appropriate lens for analysing activities and events that could explain the cluster's evolution through these different phases.

5.1 Adaptive cycle

Elements of the cluster's evolution to date can partly be explained by traditional cluster theory, especially the locational advantages that attracted firms to the original inner East London area. Its development also appears to resemble stages of orthodox life cycles described within evolutionary economics. For example, a strong argument could be made that the cluster has gone through the emergence and growth stages of Menzhel and Fornahl (2007) life cycle model.

There is evidence to suggest, however, that the collapse of an emerging new media concentration in the early 2000s led to the release of resources that were reorganised into the early development of this current tech cluster. In addition, the increasing heterogeneity associated with this cluster does not fit more typical life cycles but is incorporated into an adaptive cycle model (Sunley and Martin, 2011).

The findings of this study would appear to suggest that the cluster has gone through at least two phases of the adaptive cycle: reorganisation and exploitation. Changes to the adaptive dimensions of accumulated resources, connectedness and resilience resemble those described in the literature (Simmie and Martin, 2009). There is little evidence that it has reached the conservation phase of the adaptive cycle just yet as the dimensions are still on an upward trend. However, the criticism around loss of creativity and flexible space would suggest that the cluster has moved past the early stages of the exploitation phase.

5.2 Complexity leadership

This study managed to identify the existence of specific strategies within the cluster's development that are associated with the three leadership functions envisioned by Uhl-Bien et al's (2007) Complexity Leadership Theory. The analysis of strategies used within different phases of the cluster's evolution also shows that administrative leadership played a much larger role during exploitation than reorganisation.

During the reorganisation phase, enabling leadership strategies such as the creation of interactive co working spaces, informal networking and the championing of the cluster by key individuals had a large influence. Key adaptive outcomes were the initial naming of the cluster, growing self-identification of firms and the setting up of dedicated hubs for start-up activity.

A meeting between a local entrepreneur and an advisor to the Prime Minister was the trigger for the development of an initiative that provided the cluster with a bolder vision and potential. The transition from Silicon Roundabout to Tech City was more than just a name change. It created a new identity with new associated meanings of what the cluster represented.

The exploitation phase has involved more administrative strategies such as strategic planning, policy development and the allocation of greater resources to support cluster growth. Enabling strategies are still important, though, with an increase in interdependence between cluster agents fostered by accelerator programs, incubators and collaborative partnerships. Key

adaptive outcomes include government and large firms adjusting products and processes in order to connect with the cluster.

Uhl-Bien et al. (2007) describe emergence as a product of self-organisation and the "reformulation of existing elements to produce outcomes that are qualitatively different from the original elements" (p.308). It could be argued that the key ingredients for the cluster – related variety and distributed connectivity – were apparent during the reorganisation stage and that they have been merely amplified during exploitation. However, there seems to be no doubt that the establishment of Tech City and related initiatives has given a fundamental new meaning and identity to the cluster.

5.3 Contribution to cluster based policies

This study would seemingly support the general consensus that cluster initiatives are more successful when amplifying existing potential of localised industry concentrations rather than trying to generate altogether new clusters (Martin and Sunley, 2003). The Tech City initiative and actions by other administrative agencies worked to enhance the actions of an already active local business community.

It is impossible to say for certain whether the cluster would have experienced such growth and such an injection of resources that have occurred in recent years without this more administrative assistance. However, there is a general perception that support was warranted and to some extent inevitable.

What is also apparent is that the incorporation of feedback from local entrepreneurs and the involvement of multiple stakeholders in certain administrative decisions have led many people to perceive government's involvement as facilitative rather than directive. It is not completely clear that this has been the key to the cluster's growth thus far but it is arguably one of the key factors.

5.4 Applicability of models

Even complexity leadership proponents acknowledge that the study of complex systems and the role of leadership within CAS are still in its infancy (Goldstein, 2008). Despite this, the concept of leadership being an emergent dynamic from interactions between organisations and individuals proved easier than expected to explain to research participants. People were comfortable outlining transformative collaborations or events rather than just the individuals involved.

Generally, this study has found the adaptive cycle model and complexity leadership theory as useful mechanisms for analysing cluster evolution. However, due to both being developing models they contain certain limitations that generated challenges for the researcher.

Sunley and Martin (2011) have noted that the adaptive cycle model can often be too restrictive in terms of limiting the evolution of a system to four phases. As this study has noted it raises questions in terms of whether or not to incorporate certain periods of cluster development to one phase or the other. Using a finite set of dimensions to measure cluster evolution is also difficult. Certain dimensions such as resource accumulation lend themselves to the generation of identifiable indicators much more easily than something such as resilience.

Utilising conceptual elements of complexity leadership in an actual case study is also more difficult than just theorising on the topic. Nooteboom and Termeer (2013) have highlighted the difficulty in categorising strategies with regards to complexity leadership functions. Actions identified during this study could often be classified under multiple categories. It was also often

difficult to assess whether certain actions were enabling the cluster 's growth or simply specific organisations within it, and whether this distinguishment was necessary.

In addition, the list of strategies identified during this study is not exhaustive. The number and range is limited by the number of actors within the cluster who agreed to participate in the study and also the researcher's brief timeframe for investigation. A longer and more involved observation of actions and events within the cluster would arguably generate a larger and more accurate list of strategies.

There are also difficulties in determining between complexity leadership strategies and adaptive dimensions. For example, Simmie and Martin (2009) describe economic resilience in terms of the creative and flexible responses of firms, which also would be interpreted as strategies of adaptive leadership.

5.5 Validity and reliability

In addition to the limitations regarding the models used for this study, other factors have also influenced the development and analytical interpretation of findings.

The brevity in allocated fieldwork time affected the potential access to research participants and therefore also the confirming of participant's accounts amongst a greater range of individuals. It also restricted the ability of the researcher to conduct a survey assessing individual's opinions of the most influential complexity leadership strategies that would have possibly reinforced findings.

The researcher's own disassociation with the cluster, whilst limiting research bias or subjective influence, also limited the potential access to participants and observations of cluster activity. The researcher's lack of close familiarity with the industry being studied and its associated terminology may have additionally impacted interpretation of data.

Findings are also influenced by the imperfect information regarding the entire period of the cluster's evolution. Finding secondary data or individuals who could provide historical accounts of the 1990s dot.com boom proved difficult. Most individuals accessible for interviews also had limited association with the cluster prior to the last four to five years.

Restrictions on access to secondary data may have affected the validity of analysis. Some quantitative data was prohibited to public users, which made assessing adaptive cycle phases difficult. Access to government and organisational meeting notes would also greatly improve assessment of complexity leadership strategies.

In addition, the use of qualitative data analysis tools such as ATLAS.ti involves a large amount of subjective categorisation of both indicators and their identification in the field. For example, the choice of which strategies adequately reflect different leadership functions and what denotes adequate examples of these strategies is open to the researchers interpretation.

5.6 Recommendations for further research

This study has added to the small but growing research focussed on complexity models of cluster evolution. It also provides a relevant case example for analysing the general applicability of adopting complexity leadership theory as an explanatory tool for the evolution of complex adaptive systems.

This study has also enabled the identification of areas of future research that would further progress the understanding of complex systems and clusters in particular.

Sunley and Martin (2011) note that cluster evolution needs to be considered not in isolation but in terms of the industry it is a part of. The trend growth in the creative tech industry more

broadly and its association with entrepreneurial behaviour seems to have influenced the East London cluster's development. This would suggest this is an appropriate area for further study.

There were obvious limitations on validating findings regarding influential complexity leadership strategies in the given timeframe. This would suggest that follow-up studies that focus on testing the importance of specific strategies in different phases of cluster evolution would be warranted.

Given the relative newness of the two conceptual models used for this study, there is also a necessity for additional studies that apply them to the analysis of the development of other complex systems.

In addition, the combination of complexity leadership theory and adaptive cycles has not been explored in great detail thus far. This study would suggest there is potential scope for adopting a similar conceptual framework for analysis of the evolution of other industry clusters and also the study of emergent systems more generally.

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Appendix 1: Definition of industries in the UK Digital Economy

ICT Sectors	Digital Content Sectors
Manufacture of office machinery and computers	Publishing of books
Manufacture of computers and other information processing equipment	Publishing of newspapers
Insulated wire and cable	Publishing of journals and periodicals
Electronic valves and tubes and other electronic components	Publishing of sound recordings
Television, radio transmitters and apparatus for telephony and telegraphy	Other publishing
Television and radio receivers, sound or video recording or producing apparatus and associated goods	Printing of newspapers
Instruments and appliances for measuring, checking, testing and navigating and other purposes	Printing not elsewhere classified
Wholesale of electrical household appliances and radio and television goods	Pre-press activities
Wholesale of computers, computer peripheral equipment and software	Ancillary activities relating to printing
Wholesale of other office machinery and equipment	Reproduction of sound recording
Wholesale of other electronic parts and equipment	Reproduction of video recording
Wholesale of other machinery for use in industry, trade and navigation	Reproduction of computer media
Telecommunications	Publishing of software
Renting of office machinery and equipment including computers	Other software consultancy and supply
Computer Hardware consultancy	Data processing
Maintenance and repair of office, accounting and computing machinery	Database activities
Other computer related activities	Advertising
	Photographic activities
	Motion picture and video production
	Motion picture and video distribution
	Motion picture projection
	Radio and TV
	News agency activities

Source: BIS, 2009